Republic of Iraq
Ministry of Higher Education
Al-Mustaqbal University
Radiology Techniques Department
Second Stage \ Special Radiological Procedures-1

Lecture No. (8)

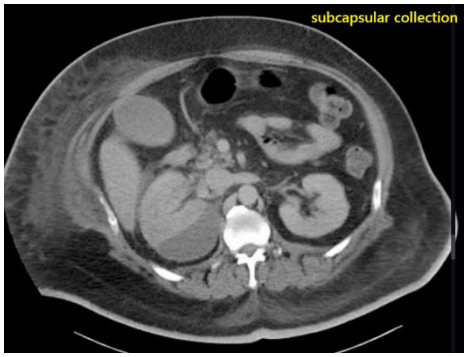
Computed Tomography of the Urinary Tract

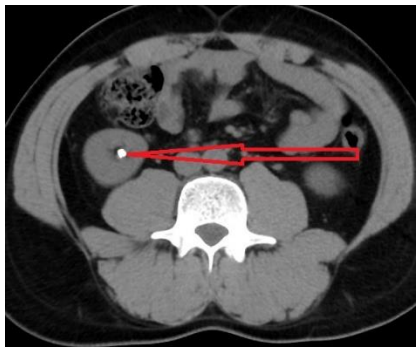
By

Dr. Samer Adnan

Computed Tomography of the Urinary Tract

Indications





1. Renal colic/renal stone disease
2. Renal tumour
3. Renal/perirenal collection
4. Loin mass
5. Staging and follow-up of renal, collecting system or prostatic cancer (CT)

*(local staging of prostatic cancer is performed using thin-section MRI)

6. Investigation of renal tract obstruction
7. CT angiography may be used to assess renal vessels for suspected renal artery stenosis or arteriovenous fistula or malformation.

Techniques

Standard diagnostic computed tomography

_____this technique is used to **stage** and **follow-up** known renal-tract malignancy **or** to investigate nonspecific signs attributed to the renal tract**.**

*Examination of the thorax in addition to the **abdomen** and **pelvis** is usually performed, where pulmonary metastatic disease or mediastinal nodal spread **is a possibility:**

1. Venous access is obtained.
2. *Patient lies supine.

Scanogram =Topogram = Scout view

صورة مفراس أولية تشبة صورة الاشعة العادية لتحديد منطقة الفحص

3. *Scanogram is taken of chest, abdomen and pelvis as appropriate.
4. *100 mL i.v. LOCM given.

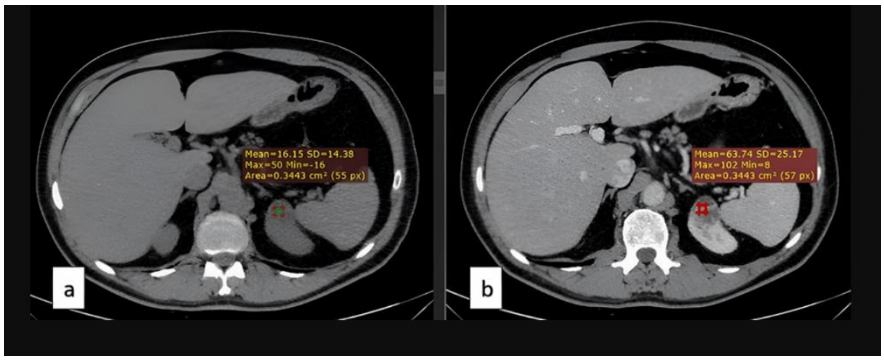
5. *Scans obtained approximately 70 s (portal venous phase) after i.v. contrast (**arterial phase** scans **of the liver** (beginning 20–25 s after the start of a bolus injection) may be appropriate in those patients with suspected metastatic renal cancer **who may have** hypervascular liver metastases).

Renal lesion characterization computed tomography

_____this is used to assess renal cysts or masses **identified on another imaging modality** such as **ultrasound**.

***Pre-** and **post-**i.v. contrast scans are obtained through the kidneys in order to assess precontrast attenuation and **subsequent** enhancement patterns.

***Many practitioners advise the p**ostcontrast** scan be performed at 100 s (nephrographic phase) **to prevent small intraparenchymal lesions** being obscured by **corticomedullary differentiation**.



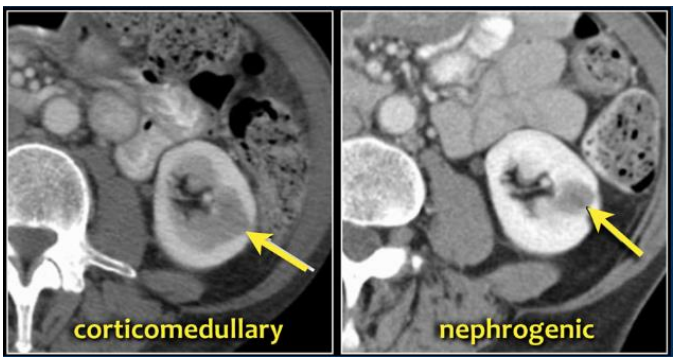


Fig. 1. Axial non-contrast

Fig. 2. Axial Corticomedullary phase

Fig. 3. Axial Nephrographic phase
parenchymal phase

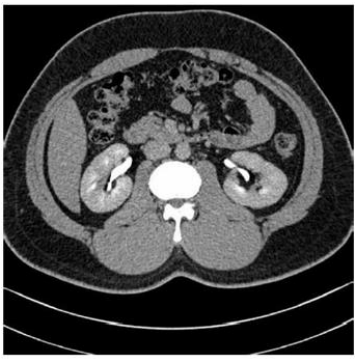


Fig. 4. Axial Excretory phase
(pylographic phase)
(delay phase)

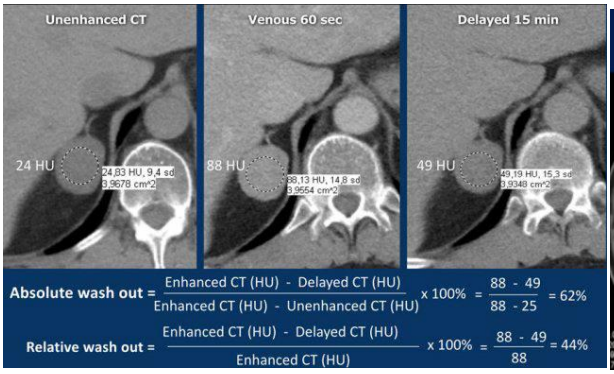
Adrenal lesion characterization computed tomography

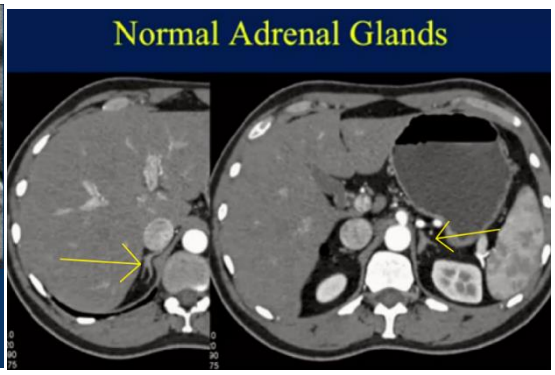
Indication: Adrenal mass is suspected **or needs** characterization.

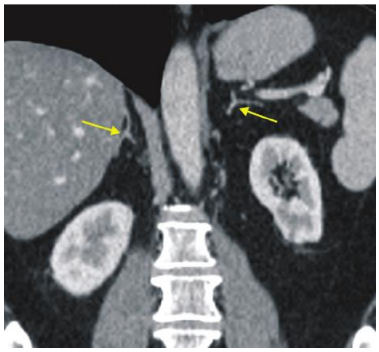
Technique: *Unenhanced CT of the abdomen to enable **measurement of attenuation (HU)** of any adrenal mass. *A value less than 10 HU is **highly specific for a benign** (lipid-rich) adenoma, and is **often the only test required**.

This may, however, be **supplemented**, when necessary, by *washout CT, **remeasurement of the adrenal density in Hounsfield units** at 15 min following i.v CM.

*Benign adenomas (**whether** or **not** lipid-rich) typically **show** rapid washout of **contrast**; an **absolute percentage washout** (APW) greater than 60% or **relative percentage washout** (RPW) greater than 40%, **on delayed images**, **is highly specific for** a benign lesion.







Computed tomography kidneys, ureters, bladder

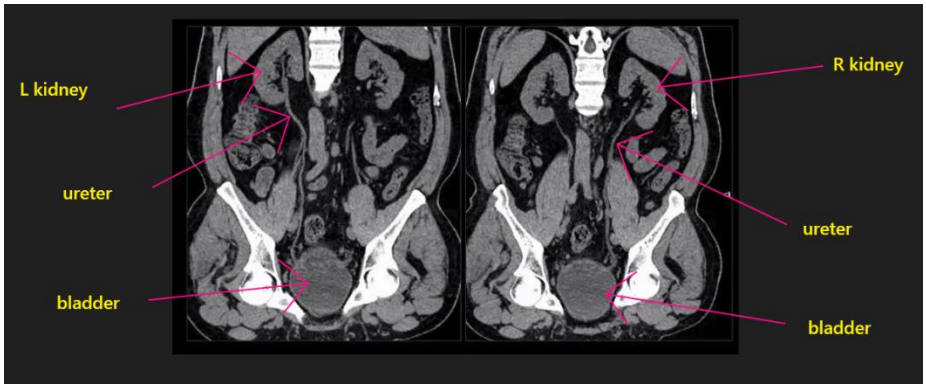
Plain CT (**commonly referred to** as CT KUB—kidneys, ureters, bladder) is **useful to assess possible** stone disease.

*It is now (CT KUB) **used in most centres** ***as the primary investigation*** of renal colic (**replacing** plain KUB radiograph):

1.* No i.v. **or** oral **contrast is given.**

2.* Patient supine. (**Some authorities advise** *prone scanning t**o differentiate if stones are impacte**d at the vesicoureteric junction **or have** passed into the bladder.)

3. *A low-radiation-dose technique is used to *scan from the top of the kidneys to **include** the bladder base with a *slice thickness of 5 mm or less, as determined by CT scanner. (***Due to the** low-dose nature of the scan and the absence of i.v. and oral contrast, the scan has a *very limited role in identifying pathology **other than** renal tract calculus disease **and** should not be used indiscriminately **for investigation** of **non-specific abdominal pain**.)



Computed tomography urogram (CTU)

This technique uses a combination of unenhanced, nephrographic and delayed scans following **i.v. contrast** to sequentially allow examination of renal parenchyma and collecting systems.

Suggested protocol includes the following:

1. *An oral water load of 500–1000 mL 45–60 min **before injection is recommended**

to ensure a **diuresis** and **collecting system dilatation**. *No positive oral contrast is given.

2. *Patient supine

3. *Initial **low-dose unenhanced scans** of urinary tract (CT KUB) to **determine if renal tract calculus disease is present**

4. *LOCM 300 mg I mL−1 100 mL is given as bolus intravenously.

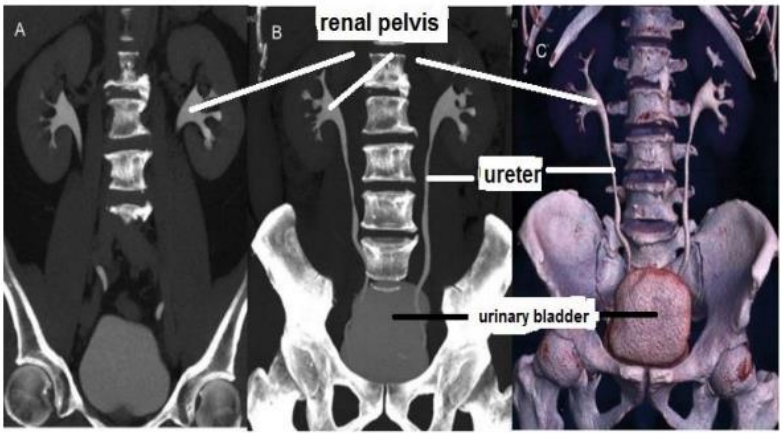
5. *Thin-section (usually 1 mm) *scans are obtained **from** the diaphragm **to** lower poles of kidneys during the *nephrographic/ parenchymal enhancement phase (100 s following start of bolus injection).

*Alternatively, the scan **may instead be** acquired during the portal venous phase (70 s), but normal corticomedullary differentiation may make small tumours **difficult to appreciate.**

6. *Delayed thin-section (1 mm) scans are acquired **from** upper pole of kidneys **to** bladder base 20 min after contrast injection, to examine collecting systems and ureters.

7. Source images are **reviewed along with multiplanar reconstructions**.

Postprocessing with maximum-intensity projections and surface-shaded displays may be **helpful**, especially for **demonstration**.



Variations

The nephrographic phase may be **omitted** if the scan is specifically for urothelial tumour or collecting system assessment.

*__Some protocols use__ diuretics or abdominal compression bands to achieve **collecting system distension**.

*Radiation dose is a significant consideration for a triple-phase CTU (compared with an IVU), but **newer iterative reconstruction** techniques **increasingly available** are **reducing this**.

*Some authorities advocate the use of a split bolus technique, i.e. 50 mL of i.v. contrast 10–15 min before scanning, with a further 50 mL at the time of the scan, to achieve demonstration of the nephrographic and pyelographic phases (delay) in the **same acquisition** with consequent **radiation dose saving**.

Computed tomography angiography

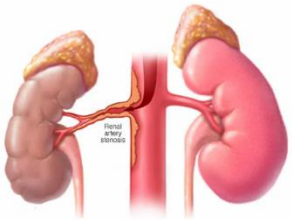
Indications

1. Renal artery stenosis

2. Renal artery aneurysm, arteriovenous malformation, dissection or thrombosis

3. Delineation of vascular anatomy prior to laparoscopic surgery, e.g. nephrectomy, pyeloplasty

Technique



1. *No oral iodinated contrast used.

2. *Scan from the upper pole of the kidneys **to the** aortic bifurcation.

***Modern scanners** are **fast enough** to produce **high quality** of the whole abdomen.

3. *Narrow collimation (1 mm).

4. *100–150 mL i.v. contrast medium (LOCM 300) injected *at 3–4 ml s−1.

5. Use of bolus tracking/triggering devices or timing test injections is recommended to ensure **appropriate timing**.

-Otherwise, scans are initiated after a preset *empiric delay of 20–25 s **from start of contrast material injection**.

6. ***Source axial scans** are ***supplemented by** multiplanar reconstructions and maximum intensity projection, and volume-rendered surface shaded display **postprocessing**

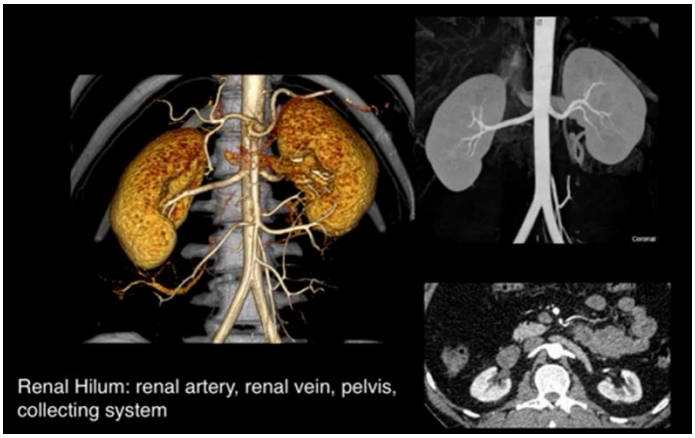


Figure 2: Axial reformats of the renal artery

Figure 3: MIP reformats of renal artery

Figure 4: Three-dimensional volume rendered image of the renal arteries

بعض الأسئلة الوزارية

Q1-uses a combination of unenhanced, nephrographic and delayed scans following i.v. contrast to sequentially allow examination of renal parenchyma and collecting systems

A. CT KUB B. CT urography C. CTA D. CT arthrography Plain E. CT

Q2-What is the recommended time for renal CT scan in order to prevent small lesions from being obscured

A. 30 seconds post contrast B. 50 seconds post contrast

C. 70 seconds post contrast D. 100 seconds post contrast

E. 300 seconds post contrast

Q3-A method(s) that is used for urological diagnosis and cancer staging is/are

A. CT adrenals B. CT KUB C. CT urography D. CT angiography

E. All of the above

Q3-What is the purpose of delayed thin-section scans in CT urogram

A. To assess for renal parenchymal disease

B. To determine renal artery stenosis

C. To examine collecting systems and ureters

D. To evaluate renal artery aneurysms

E. To review source images and multiplanar reconstructions

Q4-If the CT urography contraindicated, ... must be performed

A. Plain film B. IVU C. PET D. MR urography E. None of the above

Q5-CT angiography may be used to assess renal vessels for

A. Suspected renal artery stenosis B. Arteriovenous fistula

C. Malformation D. All of the above E. None of the above

Q6-The scan in standard diagnostic computed tomography of the renal tract is obtained at

A. Immediately after contrast administration (arterial phase)

B. Approximately 30 seconds after contrast administration (venous phase)

C. Approximately 70 seconds after contrast administration (portal venous phase)

D. Approximately 120 seconds after contrast administration (delayed phase)

E. Approximately 20-25 seconds after contrast administration

Q7-Benign adenomas (whether or not lipid-rich) typically show rapid washout of contrast; relative percentage washout (RPW) on delayed images, is highly specific for a benign lesion

A. Lesser than 60% B. Greater than 60% C. Greater than 40%

D. Lesser than 40% E. None of the above

Q8-Which technique is used to ensure appropriate timing of contrast injection in renal CT angiography

A. Oral contrast B. Bolus tracking C. Venography D. Both A & B

E. None of the above

Q9-Unenhanced CT of the abdomen to enable measurement of attenuation (HU) of any adrenal mass. A value less than ..... is highly specific for a benign (lipid-rich) adenoma, and is often the only test required

A. 45 HU B. 100 HU C. 10 HU D. -100 HU E. 1000 HU

Q10-A contrast media in standard diagnostic computed tomography of the renal tract is

A. is 10 mL i.v. LOCM B. is 100 mL i.v. HOCM

C. is 50 mL i.v. LOCM D. is 100 mL i.v. LOCM E. None of the above

Q11-What is the optimal injection rate of i.v. contrast medium (LOCM 300) in CT angiography

A. 1-2 mL/s B. 3-4 mL/s C. 5-6 mL/s D. 7-8 mL/s E. 5-8 mL/s

Q12-What is the significance of performing a postcontrast scan at 100 s (nephrographic phase) in CT imaging of the kidneys

A. To enhance the visualization of adrenal masses

B. To prevent small intraparenchymal lesions from being obscured

C. To assess corticomedullary differentiation

D. To enable measurement of attenuation of any adrenal mass

E. To visualize kidney/ureteral stones

Q13-The imaging technique is commonly used for excretory MR urography to

demonstrate the collecting systems is

A. 3D gradient echo, T1-weighted sequence

B. 4D dual-echo, T2-weighted sequence

C. Single-shot, turbo-spin echo

D. Half-Fourier rapid acquisition with relaxation enhancement

E. Diffusion weighted imaging and MR spectroscopy

Q14-What is the primary indication for performing CT angiography of the renal arteries

A. Renal tract calculus disease B. Urothelial tumor assessment

C. Collecting system assessment D. Renal artery stenosis E. All of the above