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

Lecture No. (7)

Methods of Imaging the Urinary Tract

Excretion urography (intravenous urogram [IVU])

Ultrasound of the Urinary Tract

By

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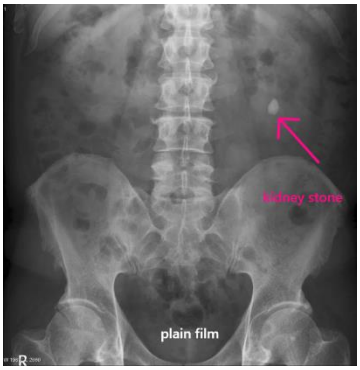
Methods of Imaging the Urinary Tract

1. Plain radiography



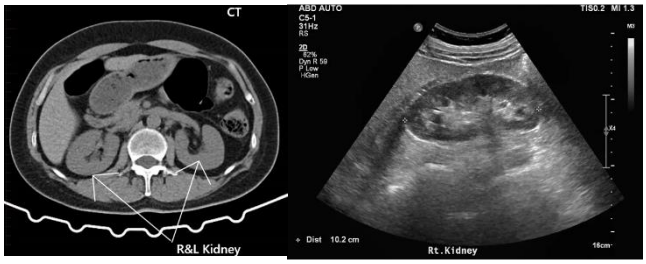
2. Excretion urography (intravenous urogram [IVU])

3. Ultrasound (US)

4. Computed tomography (CT):

(a) CT for urological diagnosis and urological cancer staging

(b) CT for characterization of renal lesion



(c) CT adrenals

(d) CT KUB (kidneys, ureters, bladder)

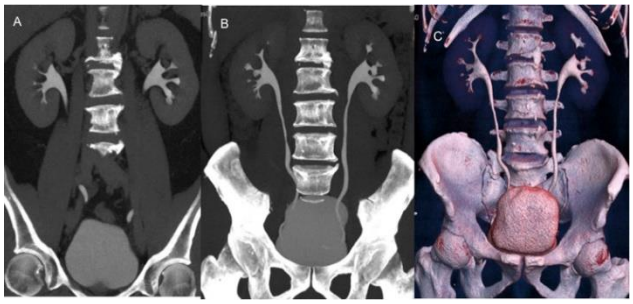
(e) CT urography (CTU)

(f) CT angiography

5. Magnetic resonance imaging (MRI):

(a) MR for characterization of renal lesion

(b) MR prostate

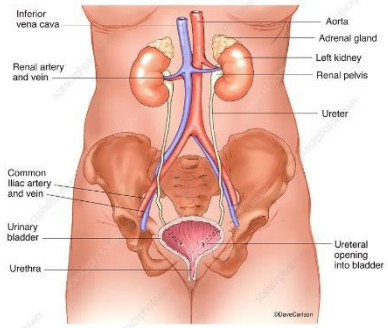


(c) MR bladder

(d) MR urography

(e) MR adrenals

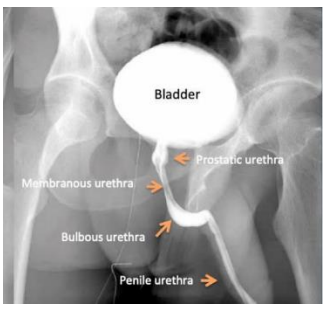
(f) MR angiography

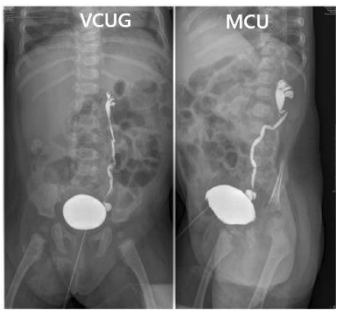


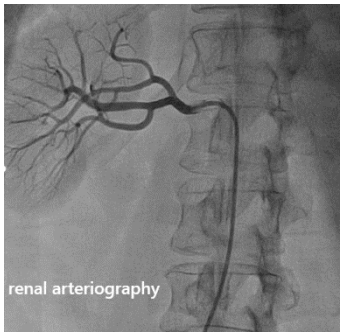
6. Micturating cystography and cystourethrography

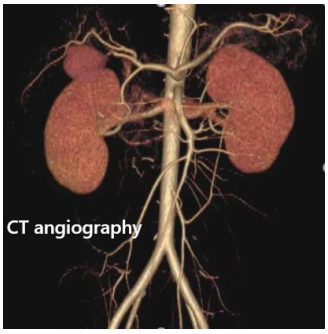
7. Ascending urethrography

8. Retrograde pyeloureterography









9. Percutaneous renal procedures:

(a) Biopsy

(b) Cyst puncture

(c) Antegrade pyelography

(d) Nephrostomy

(e) Percutaneous nephrolithotomy

10. Arteriography

11. Venography

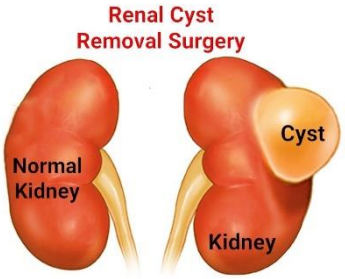
12. Conduitogram

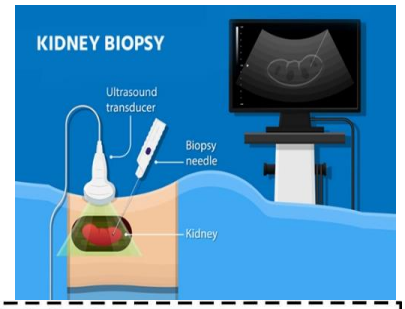
13. Radionuclide imaging:

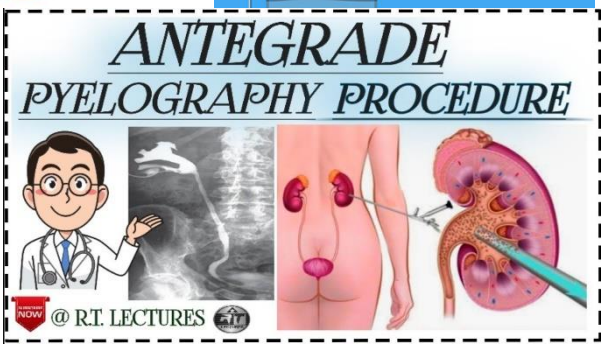
(a) Static renography

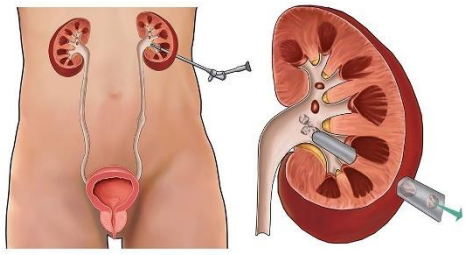
(b) Dynamic renography

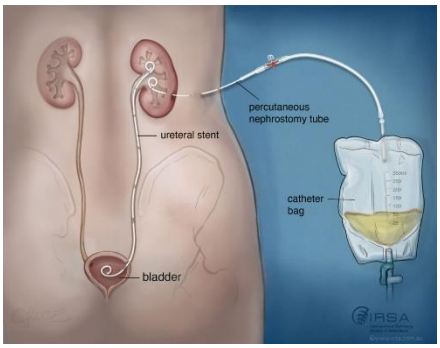
(c) Radionuclide cystography—direct and indirect







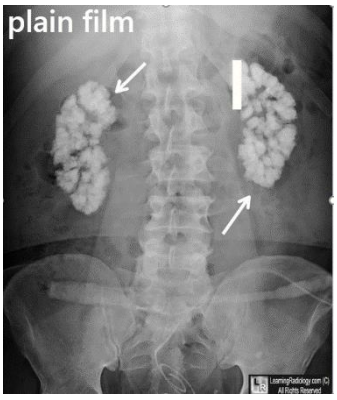


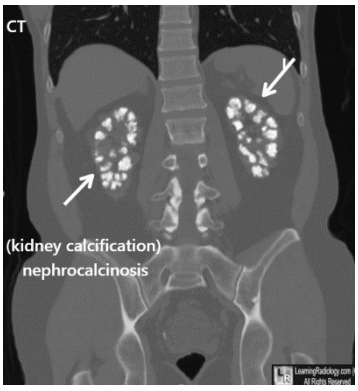


Plain Film Radiography

Indications

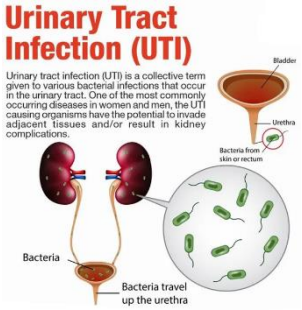
Predominantly **to evaluate renal tract calcifications—recognizing** that CT is significantly more sensitive (>98% **compared** with 60% **for** plain films).





Intravenous Excretion Urography

The technique is less frequently used than in the past and has now been very largely **replaced** by US, CT or MRI or a combination.



Indications

1. Haematuria
2. Renal colic (see the section on variation)
3. Recurrent urinary tract infection
4. Loin pain
5. Suspected urinary tract pathology

Contraindications

See for general contraindications to intravenous (i.v.) water-soluble contrast media and ionizing radiation.

*In patients with contrast medium allergies, alternative modalities such as **ultrasound** or **MR** can be considered.

*Patients with impaired renal function, particularly those with **diabetes**, should be prepared with oral or i.v. hydration, or an alternative imaging modality should be considered.

Contrast Medium

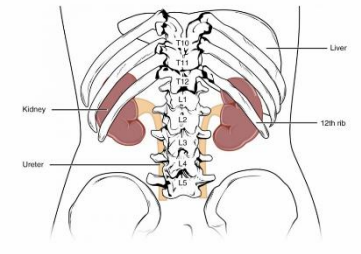
Low osmolar contrast material (LOCM) 300–370 mg I mL−1

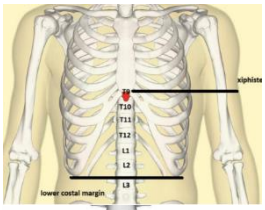
Adult dose

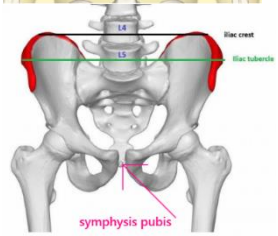
50–100 mL

Paediatric dose

1 mL kg−1







Patient Preparation

1. No food for 5 h prior to the examination.
2. Dehydration is not necessary and does not improve image quality.
3. The routine administration of bowel preparation has been shown not to improve the diagnostic quality of the examination.

Preliminary Images

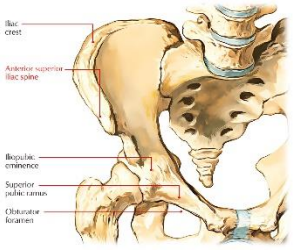
*Supine, full-length anterior posterior (AP) of the abdomen, *in inspiration.

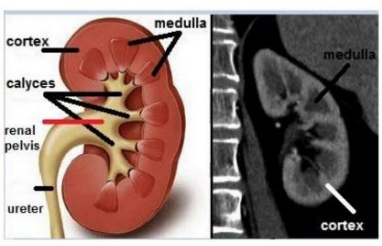
*The lower border of the cassette is at the level of the symphysis pubis, and the *x-ray beam is **centred** in the midline at the level of the iliac crests.

Q/If necessary, the location of overlying opacities may be further determined by:

1. supine AP film of the renal areas, in expiration.
2. The x-ray beam is **centred in the midline at the level of the lower costal margin**.
3. 35° posterior oblique views (side of interest towards the film)
4. tomography of the kidneys

-The examination should not proceed further until these images have been reviewed by the radiologist or radiographer and deemed satisfactory.





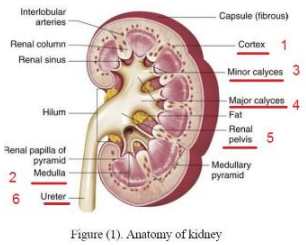
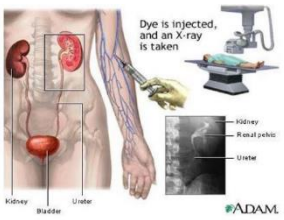
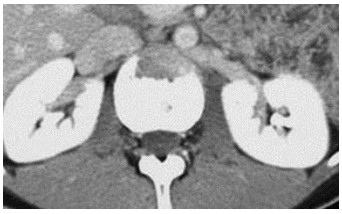


Figure (1). Anatomy of kidney

Technique: Venous access is established. The gauge of the cannula/needle should allow the injection to be given rapidly as a **bolus** to maximize the density of the nephrogram.





Images

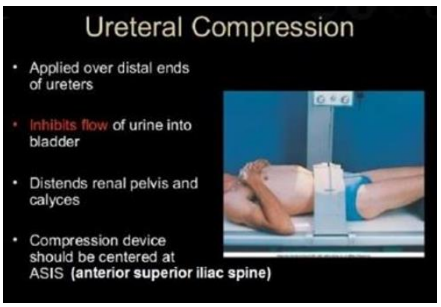
1. *Immediate film.* *AP of the renal areas. *This film is exposed 10–14 s after the injection (approximate *'*arm-to-kidney' time*). *It **aims to show** **the** nephrogram at its most dense—i.e. *the renal parenchyma opacified by contrast medium in the renal tubules.

*Tomography may assist in evaluation of the renal outline or possible masses (or **ultrasound** if subsequently available).

2. *5-min film.* *AP of the renal areas. *This film gives an initial assessment of pathology—specifically *the presence or absence of obstruction **before** administering **compression**.

A compression band is then applied positioned **midway between** the anterior superior iliac spines—i.e. over the ureters as they **cross the pelvic brim**.

The aim of **compression band** is to produce pelvicalyceal distension.



Compression is, however, **contraindicated:**

(a) after recent abdominal surgery

(b) after renal trauma

(c) if there is a large abdominal mass or aortic aneurysm

(d) when the 5-min film shows already distended calyces indicative of obstruction

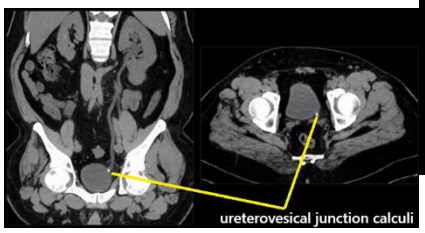
3. *10-min film*. AP of the renal areas. There is usually adequate distension of the pelvicalyceal systems with opaque urine **by this time**.

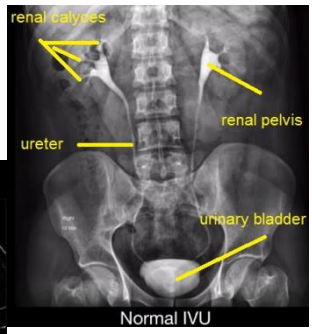
Compression is released when **satisfactory demonstration of** the **pelvicalyceal system** has been achieved.

*If the compression film is inadequate, the compression should be **checked and repositioned** if necessary and a further 50 mL of contrast medium administered and a repeat film taken after 5 min.

4. *Release film*. #Supine AP abdomen taken **immediately after the release of compression**. This film is taken to show the ureters. If this film is satisfactory, the patient is asked to empty the bladder.

5. *After micturition film*. #Full-length supine AP abdomen.





The aims of this film are to

1. To assess bladder emptying
2. to demonstrate drainage of the upper tracts
3. to aid the diagnosis of bladder tumours
4. to confirm ureterovesical junction calculi, and
5. uncommonly, to demonstrate a urethral diverticulum in females.

Additional Images

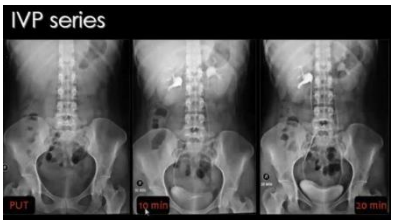
1. 35° posterior oblique of the **kidneys, ureters or bladder**—for equivocal collecting system lesions **or** localization of calculi
2. Tomography—if renal outlines are not well seen
3. Prone abdomen **following the release film**—may **improve visualization** of distal ureters
4. Delayed films at increasing (doubling of time intervals) up to 24 h after injection in renal obstruction to show level and cause of obstruction.

Figure 1

Figure 2

Variation

Renal colic—a limited study may be performed:



1. preliminary films;
2. 20-min full length (no compression);
3. postmicturition full length;
4. delayed films up to 24 h as **required to show level and cause of obstruction.**

Ultrasound of the Urinary Tract

Indications

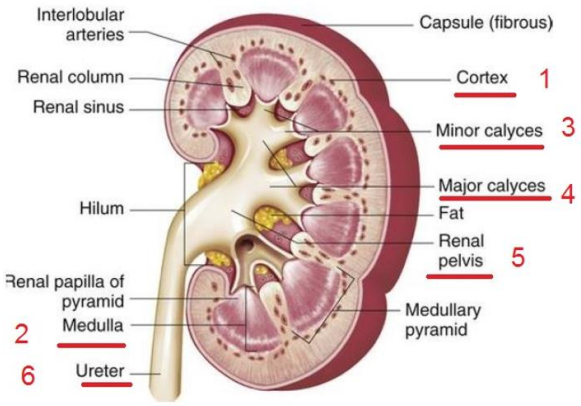


Figure (1). Anatomy of kidney

1. Renal mass lesion
2. Renal parenchymal disease
3. Renal obstruction/loin pain
4. Haematuria
5. Hypertension
6. Renal cystic disease
7. Renal size measurement
8. Bladder outflow obstruction
9. Urinary tract infection
10. Bladder tumour
11. Following renal transplant:

(a) Obstruction

(b) Patency of vessels

(c) Perirenal collections.

12. To guide needle placement in interventional procedures
13. Renal vascular studies.

Contraindications

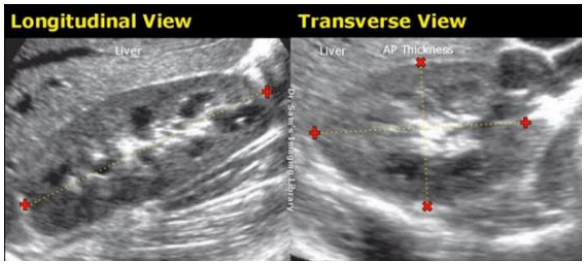
None.

Patient Preparation

Kidneys only ⟶ none.

Kidneys and bladder ⟶ perhydrate with oral fluids, e.g. 500–1000 mL **1 h** before scan; patient attends with a **full bladder**.

* This may **have the disadvantage** of making the **collecting systems appear** mildly hydronephrotic **premicturition**.



Equipment

3.5–5-MHz **transducer**.

Technique

1. Patient supine, right (RAO) and left anterior oblique (LAO) positions or lateral for **kidneys**.

*The kidneys are scanned longitudinally in an oblique coronal plane **supplemented by** transverse sections **perpendicular** to the **axis**.

***The right kidney** may be scanned through the liver and posteriorly in the right loin.

***The left kidney** is **harder to visualize** anteriorly, **but can be visualized** from a lateral **approach.**

*In **difficult cases**, the patient should **lie on their side** with a **pillow under the loin** to **widen the space *between*** the rib cage and pelvis.

2. The l**ength of the kidney measured by US** is 1–2 cm smaller **than that measured at excretion urography**, because there is **no geometric magnification**.

***With **US measurement**, care must be taken to ensure that the true **longitudinal length** measurement is obtained.

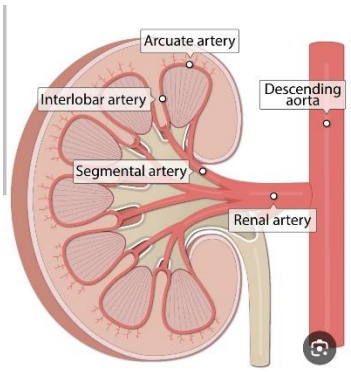
*The range of **lengths** of the **normal kidneys** is 9–12 cm, and the difference between each kidney should be less than 1–2 cm.

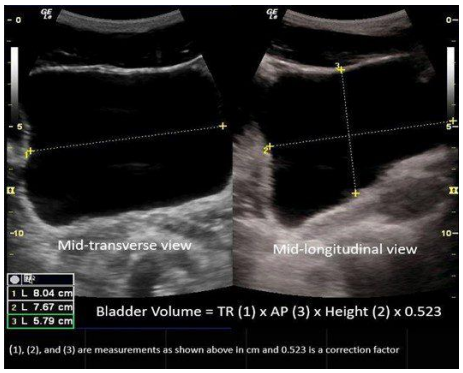
3. The bladder is scanned suprapubically in **transverse** and **longitudinal** planes.

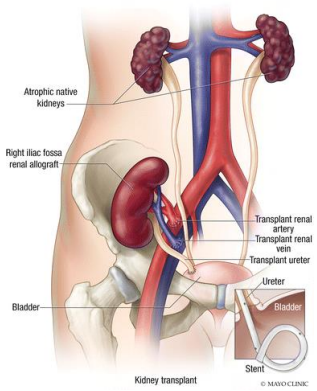
*Measurements taken of the **three orthogonal diameters before** and **after micturition**

enable an **approximate volume** to be *calculated by* multiplying the three diameters and **applying a conversion factor**. (A conversion factor [**approximately** 0.5] is *usually* **preprogrammed into modern ultrasound machines**.)

4. **Renal transplants** are *usually* **located** in the right or left iliac fossa. These **lie fairly superficially** and are **easy to evaluate** using oblique planes and gentle pressure to displace overlying bowel loops.





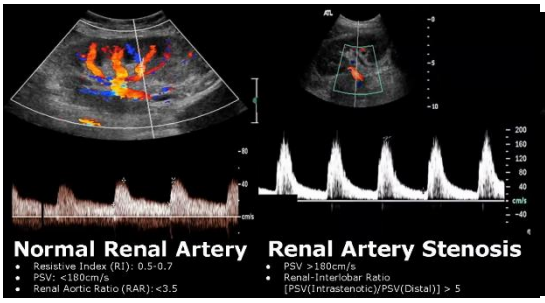


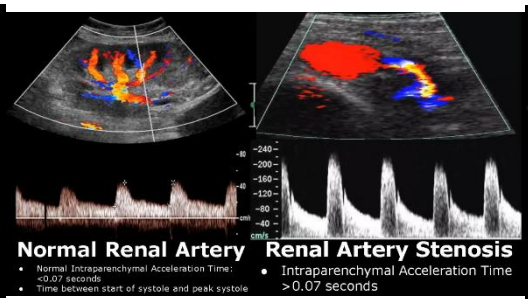
5. The **native** or **transplant kidneys** can be **evaluated** for vascular pathology using **Doppler techniques.**

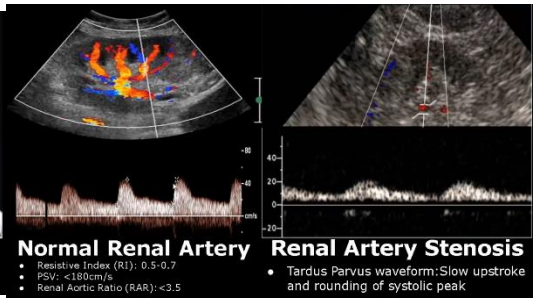
• Renal artery stenosis is **diagnosed** by **direct Doppler interrogation** of the main renal arteries from a transabdominal approach.

***Elevated peak systolic velocities** >200 cm s−1 are **suggestive** of a >50% stenosis.

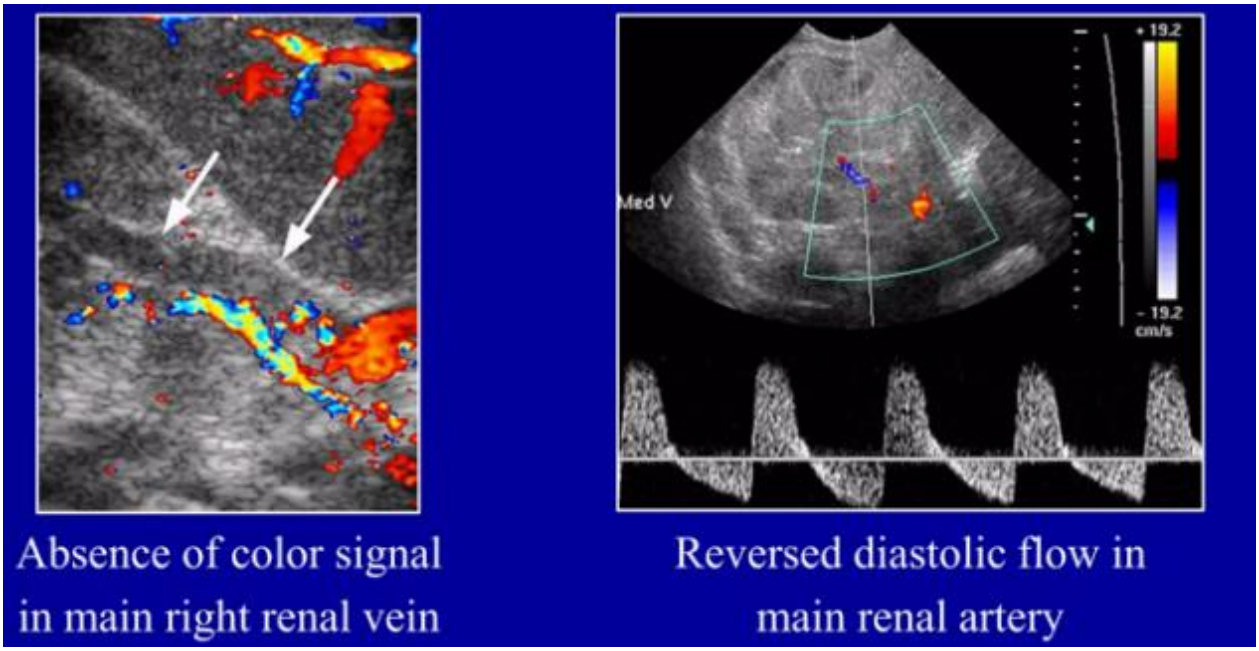
***Alternatively**, as the main renal arteries in the **native kidneys** are often hard to visualize, the intrarenal arteries can be evaluated from a flank approach for downstream changes in waveform—the tardus parvus **pattern**, a slow rise (tardus) to a reduced peak (parvus), **producing a prolonged acceleration time** (a value >70 ms is **indicative** of a severe stenosis).

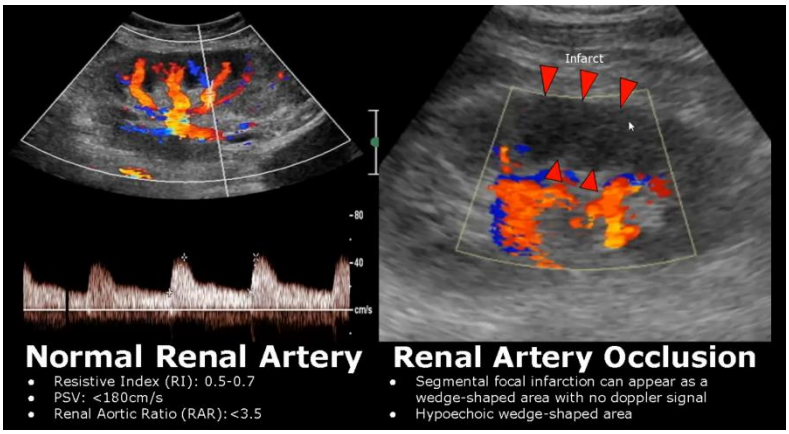


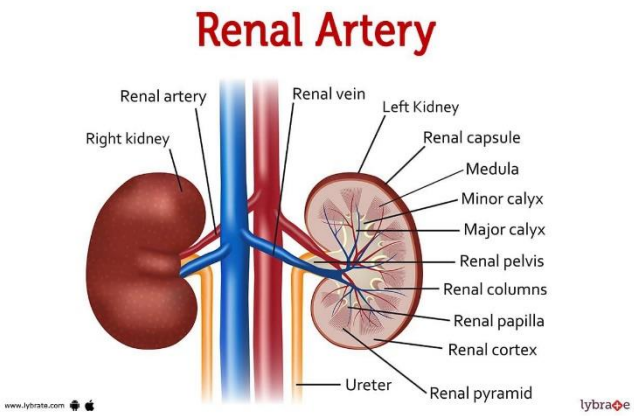




• Renal vein thrombosis is **diagnosed** by * absent colour **Doppler venous flow**, * direct visualization of thrombus **within the distended vein**, and * a raised resistive index **with** *reversal of arterial diastolic flow **within** the **intrarenal arteries.**







uro (U) جهاز بولي

kidney = renal = pyelo = nephro = كليه

ureter = uretro = حالب

bladder = cysto = مثانة

urethra = urethro = احليل