



Radiology Of The Renal System

*Everything with **grey** is extra*

Reference:
- Doctors slides.

Objectives:

- ▶ **Modality used for assessment of the urinary system:**
 - ▶ X-ray.
 - ▶ US.
 - ▶ CT.
 - ▶ MRI.
 - ▶ Nuclear.
- ▶ **Normal anatomy.**
- ▶ **Common pathologies:**
 - ▶ Kidney.
 - ▶ Ureter .
 - ▶ Bladder.
 - ▶ Urethra.

Remember:

In reading a scan image your right is left and your left is right (like looking in the mirror or shaking hands).

Ultrasound

Pros :

- no ionizing radiation. Which makes it safer for pregnant ladies and babies.
- inexpensive.
- **portable.** patients who cannot move (ICU, ER and OR patients)

Cons :

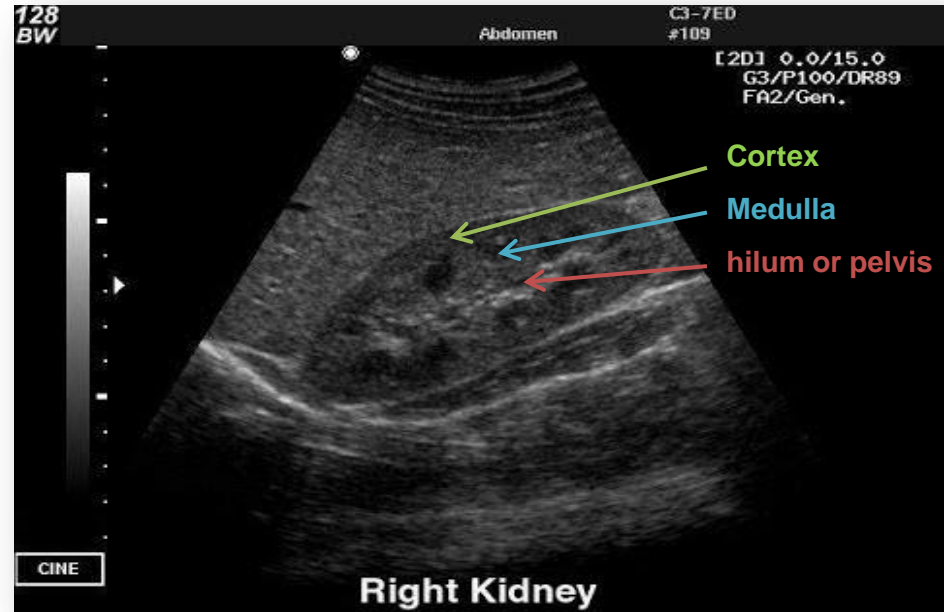
- **operator dependent.** Needs an expert
- time consuming.

Image key: shades (echoes)

White = stones, air and calcification (high reflection).

Grey = soft tissue (soft reflection).

Black = fluid (no reflection).



X-ray

Pros :

- inexpensive
- quick

Cons :

- ionizing radiation
- **not definitive** especially for soft tissues

Since normal X-ray (image 1) is not clear we use **IVP** (**Intravenous pyelogram**), we inject the patient with a pigment stain (contrast) then wait for 10 min and take another image (image 2)

*note that this method is so old that we don't use it any more instead we use CT.

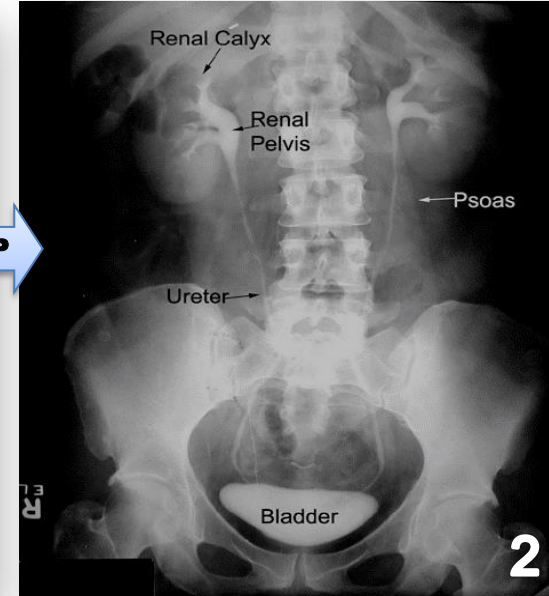
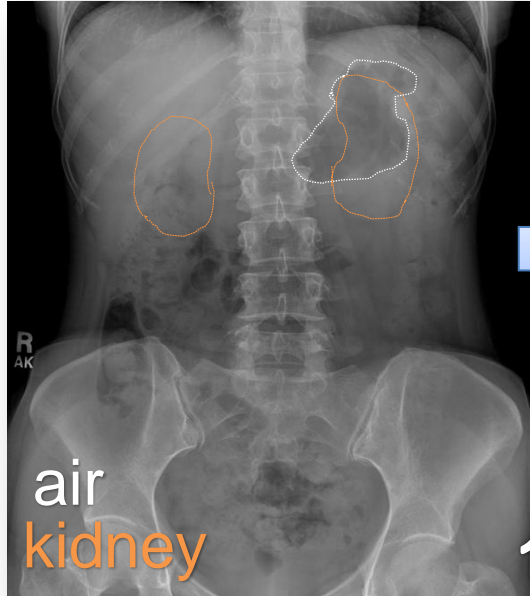


Image key: shades (densities)

White = bone and calcification (high atomic=blocks the x-ray).

Black = air (low atomic=x-ray gets through it).

CT

Pros :

- **quick.** Takes seconds to minutes
- **a lot of information.** images are clearer

Cons :

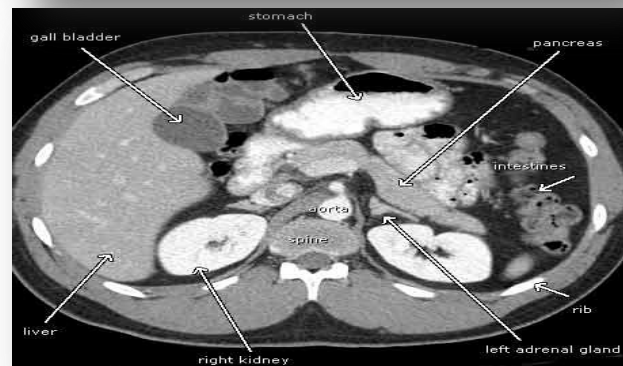
- **ionizing radiation.** the amount of radiation in CT equals almost 500 times of the x-rays radiation
- **expensive.**

Image key: shades (densities)

White = bones and calcification.

Grey = soft tissue.

Black = air.



MRI

Pros :

- **no ionizing radiation.** It uses strong magnetic fields, radio waves, and field gradients to form images of the body
- a lot of information.

Cons :

- expensive.
- **time consuming.**

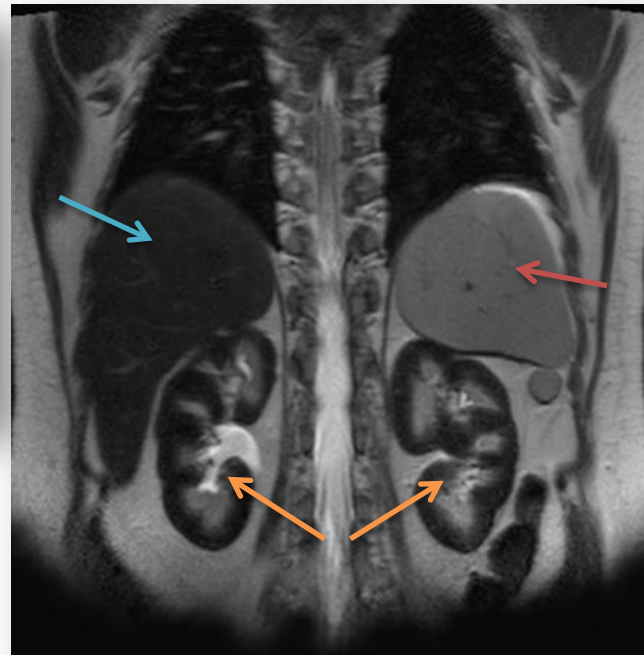
Image key: shades (intensities)

White = high intensity.

Grey to black = low intensity.



In this image you can see the babies brain, spin, kidney and even the placenta.



Kidneys – Liver – spleen

Nuclear scan

Pros :

- **assess the function** the details are not clear but it gives you an indication about the function of the kidneys,

Cons :

- time consuming.
- **radioactive materials.** We give the patient a radioactive material then wait for 4-5 hours and take images by a gamma camera.



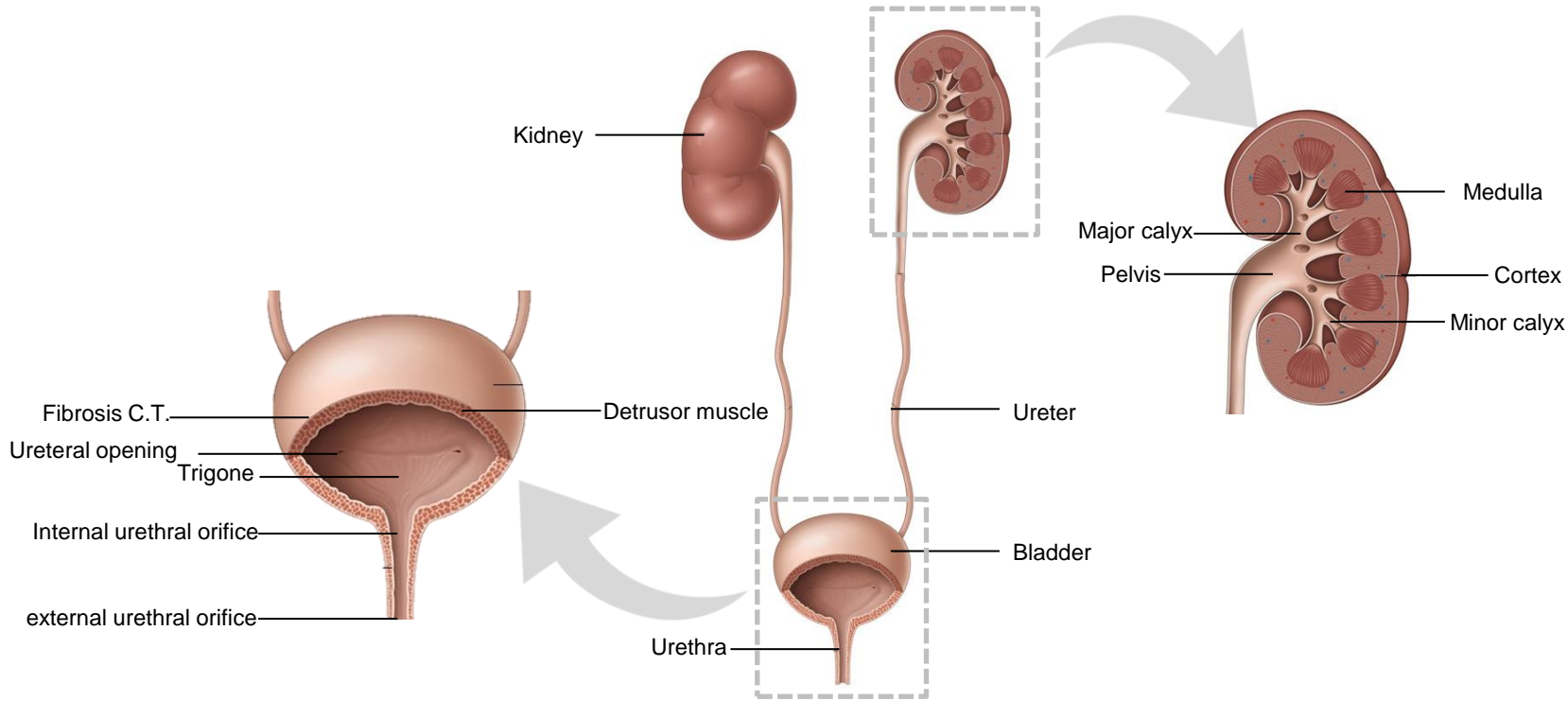
To some up things

الصفات المكتوبة باليولد هي اهم الصفات التي تميز الجهاز عن غيره

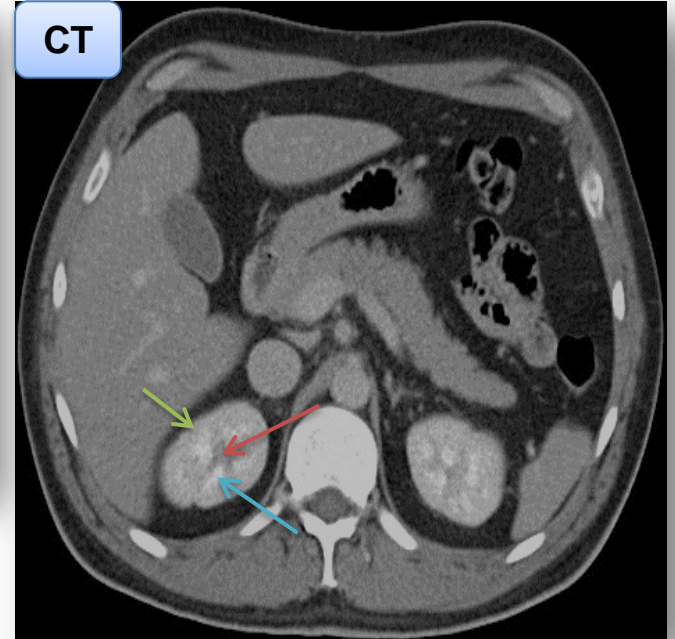
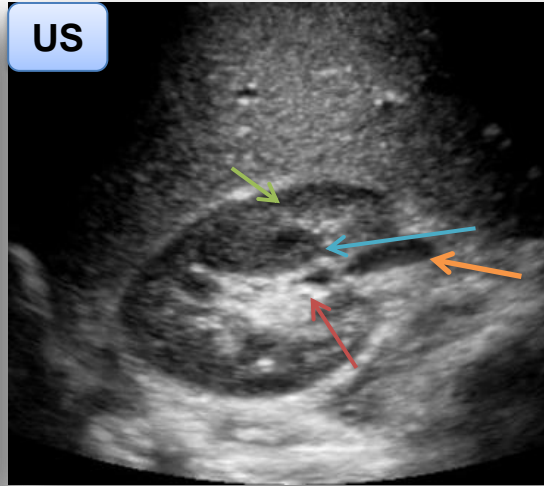
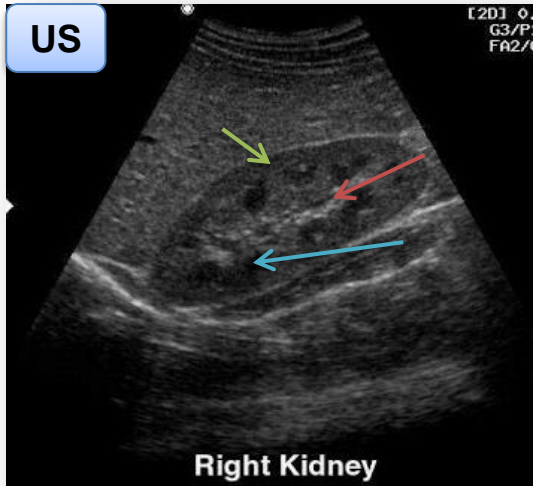
modality	US	X-ray	CT	MRI	Nuclear
Pros	<ul style="list-style-type: none">No Ionized radiation.Cheep.Portable.	<ul style="list-style-type: none">Cheep.Quick.	<ul style="list-style-type: none">Quick.Gives lots of information.	<ul style="list-style-type: none">No Ionized radiation.Gives lots of information.	<ul style="list-style-type: none">Assess the function.
Cons	<ul style="list-style-type: none">Operator dependent.Time consuming.	<ul style="list-style-type: none">Ionized radiation.Not defective.	<ul style="list-style-type: none">Expensive.Ionized radiation.	<ul style="list-style-type: none">Expensive.Time consuming.	<ul style="list-style-type: none">Time consuming.Radioactive materials.



Urinary System Anatomy

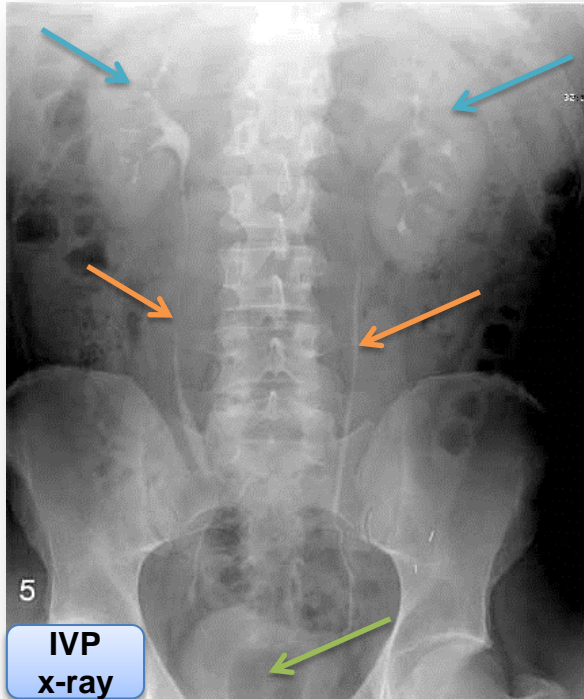


Kidneys

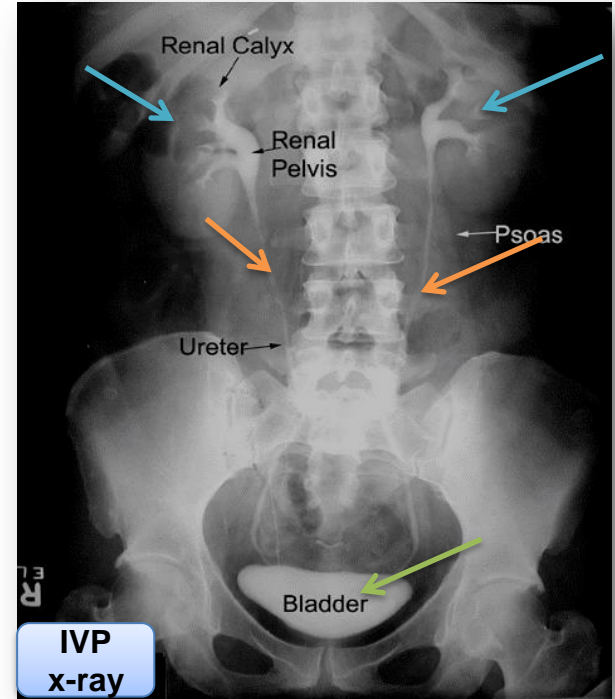


- **Renal Cortex.**
- **Renal Permed or Medulla.**
- **Hilum or Pelvis.**
- **Ureter**

Ureters

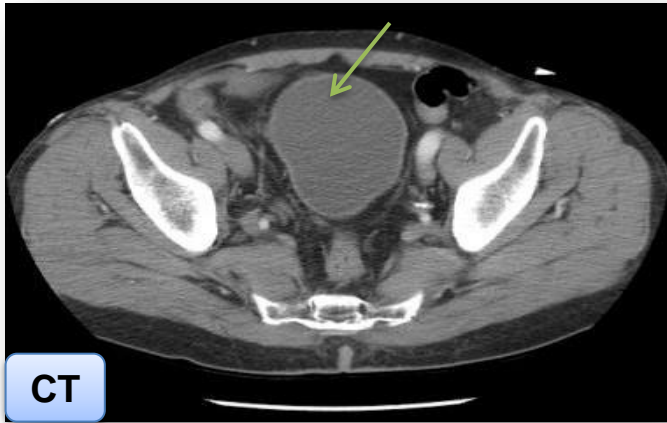


- **kidneys.**
- **Ureter.**
- **Bladder.**

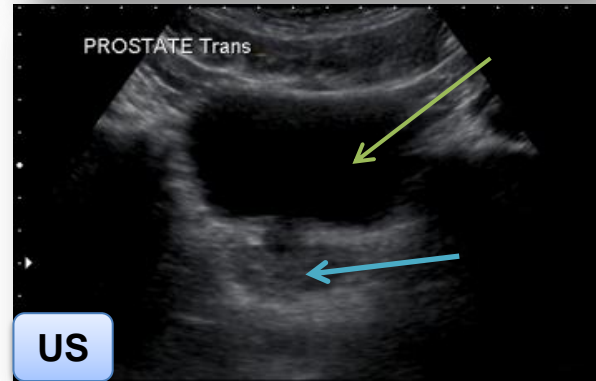
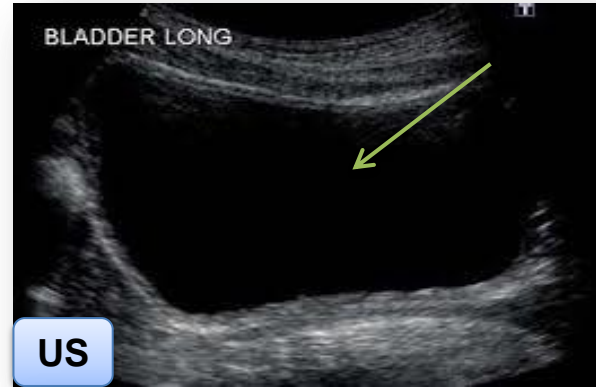


Urinary Bladder

The bladder is black cause its filled with urine.

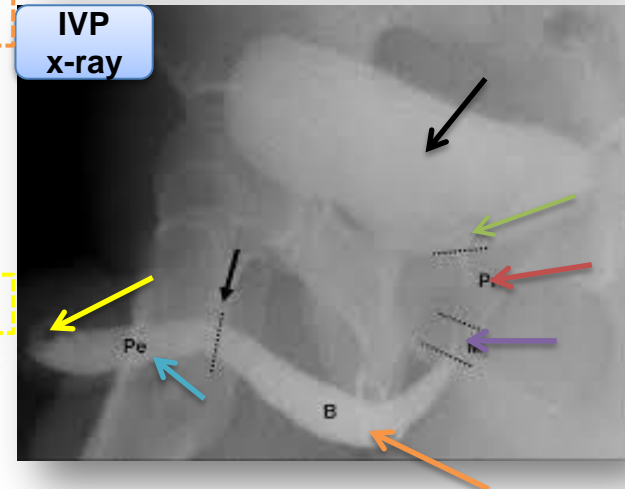
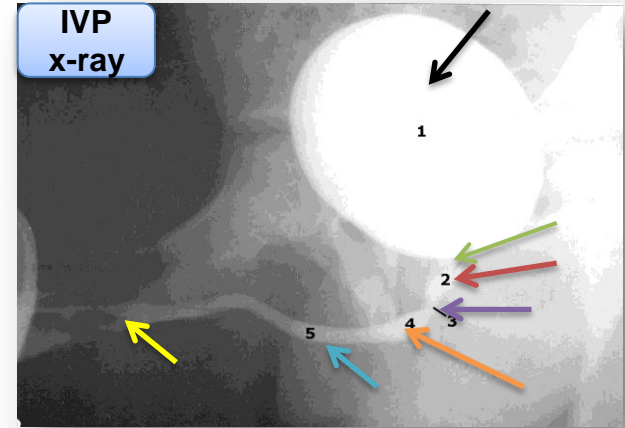
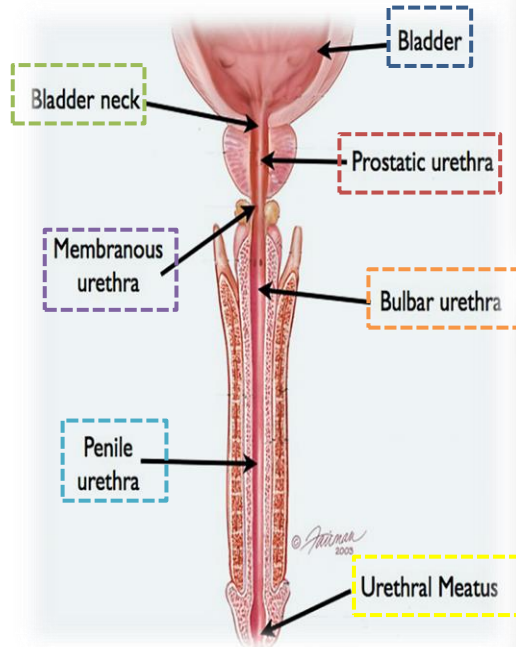


- **Bladder.**
- **Prostate.**

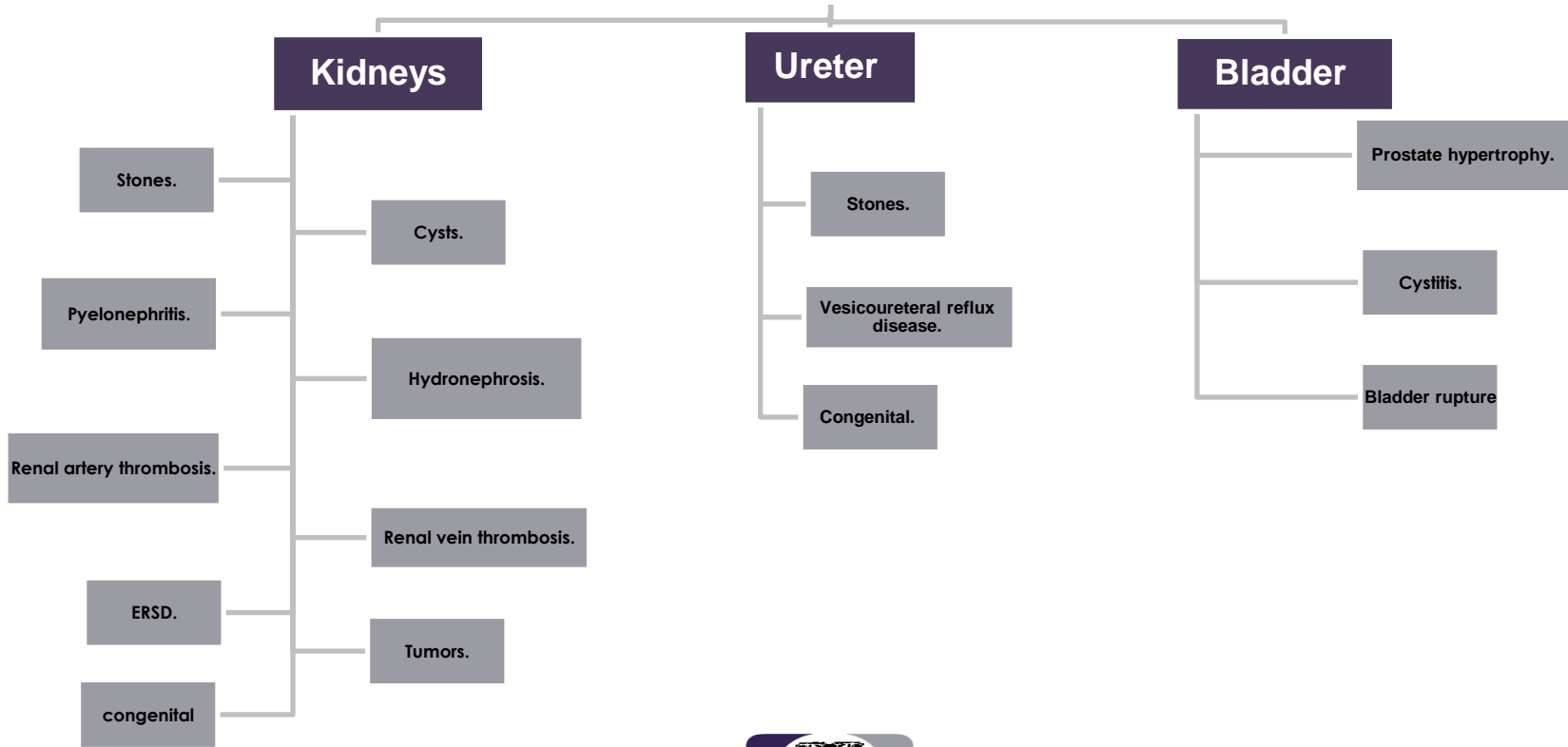


Urethra

- **Bladder.**
- **Bladder neck.**
- **Prostatic urethra.**
- **Membranous urethra.**
- **Bulbar urethra.**
- **Penile urethra.**
- **Urethral meatus.**



Common Urinary Pathologies

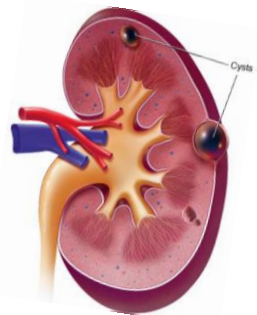


Common Kidney Pathologies

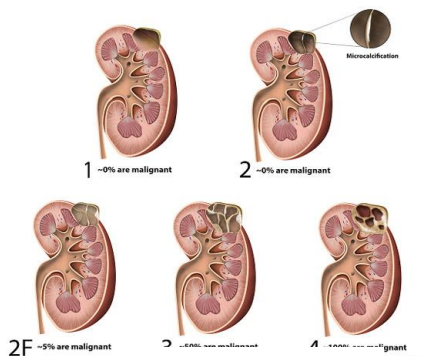


Kidney Cysts

- **Benign.**
- **Common.**
- **Bosniak classification.** It divides renal cystic masses into five categories based on imaging characteristics on contrast-enhanced CT. It's helpful in predicting a risk of malignancy and suggesting either follow up or treatment. ([Read more](#))



Bosniak classification of renal cysts



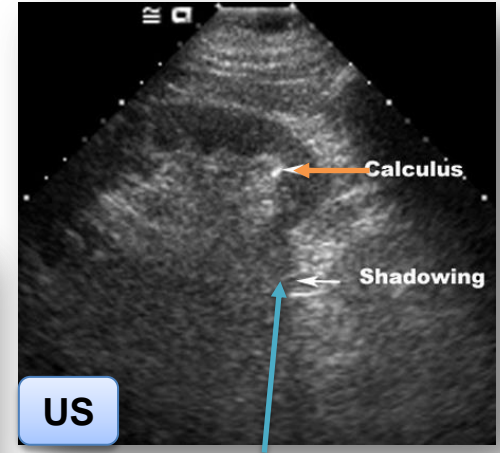
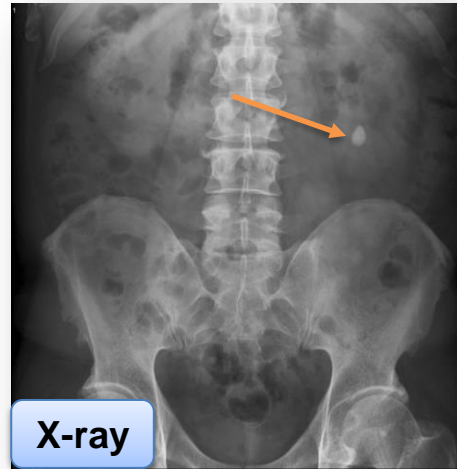
Kidney Stones

- **Radio-opaque (calcium , struvite).**

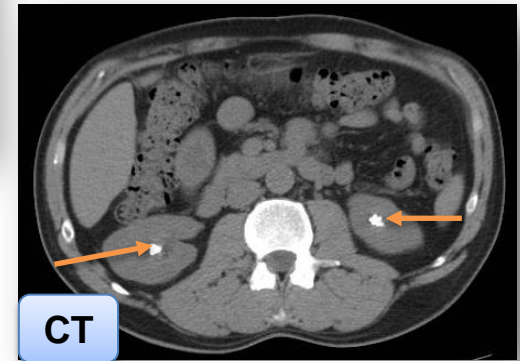
Referring to a material or tissue that blocks passage of X-rays, and has a bone or near-bone density; radiopaque structures are white or nearly white on conventional X-rays, **so it appears in imaging.**

- **Radio-lucent (uric acid , cysteine).**

materials that allow x-rays to penetrate with a minimum of absorption, **so it doesn't appear in imaging.**

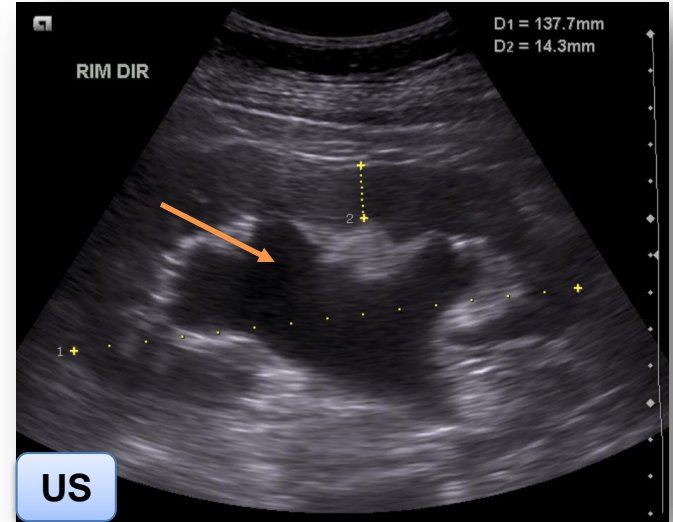
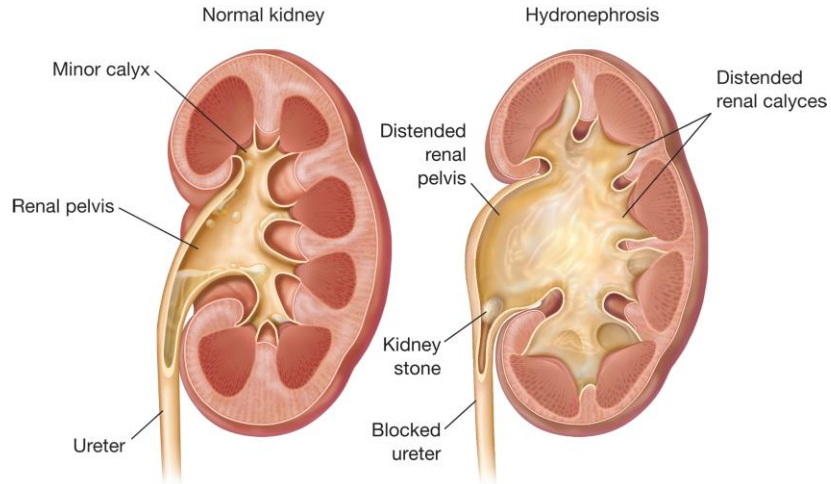


Shadow caused by the stone



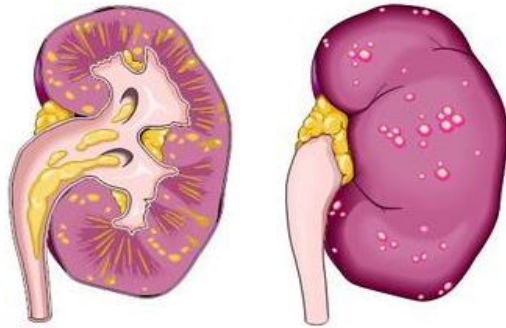
Hydronephrosis

Hydronephrosis is a condition that typically occurs when the kidney swells due to the failure of normal drainage of urine from the kidney to the bladder.



Pyelonephritis

Pyelonephritis is the infection of the kidney. Acute pyelonephritis results from bacterial invasion of the renal parenchyma. Bacteria usually reach the kidney by ascending from the lower urinary tract.



*note that usually we don't do a CT scan for a patient with pyelonephritis, we do it only if the patient doesn't respond to the treatment or he had a recurrent pyelonephritis.

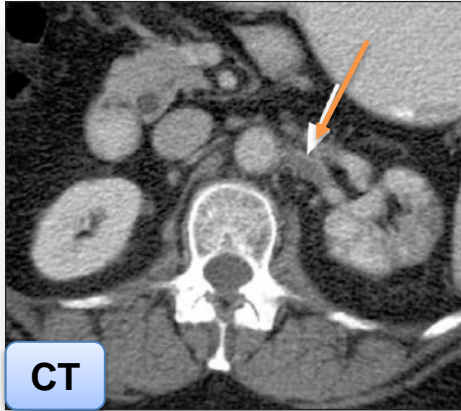


CT

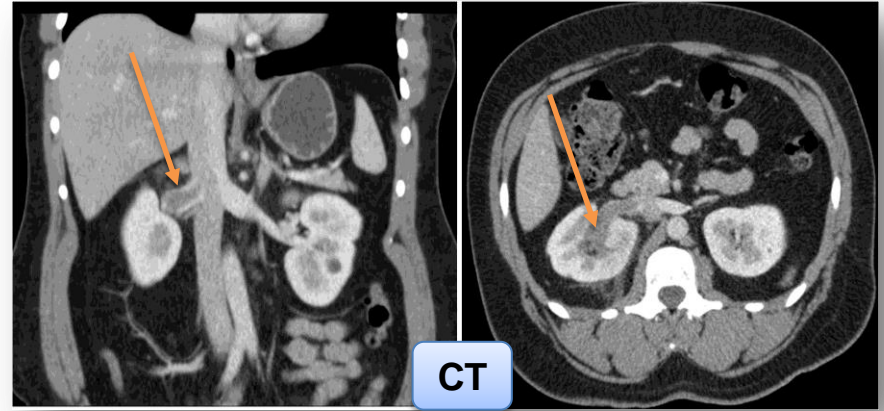


Renal Thrombosis

- **Renal Artery Thrombosis**



- **Renal Vein Thrombosis**

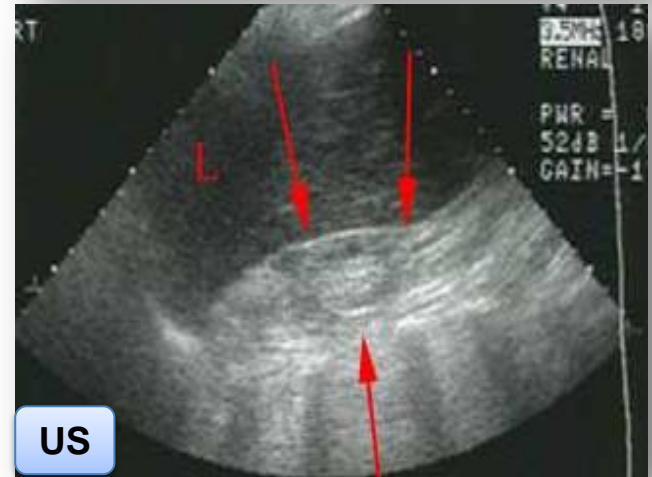


ESRD

ESRD stand for end-stage kidney disease, it means the kidney is not functioning anymore.

So in this case the patient do dialysis or kidney transplant.

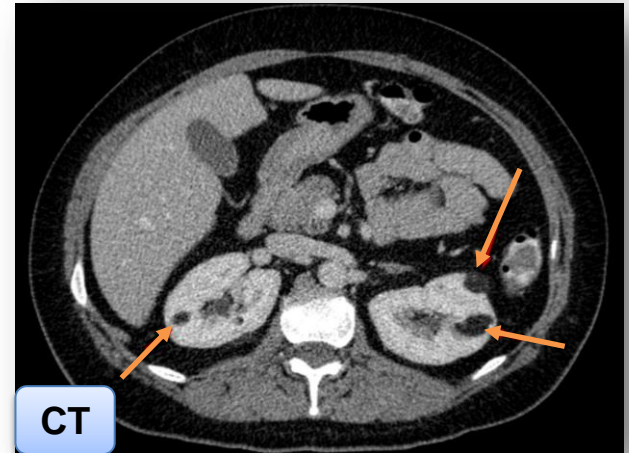
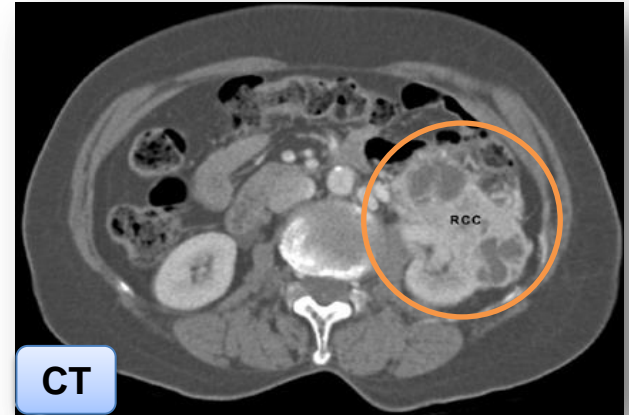
*note that in this image you can see the kidney became smaller and whitish unlike the normal kidney US the kidney is darker.



Tumors

- Benign, most common benign is angiomyolipoma
- Malignant, most common type is renal cell carcinoma

*To differentiate between tumors, cysts and stones:
Stones are white, cysts are black and tumors are in between (dark grey)



Congenital Kidney disorders

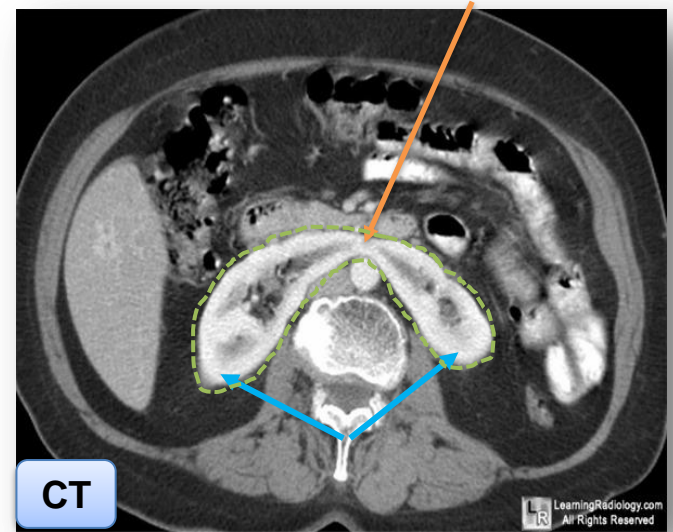
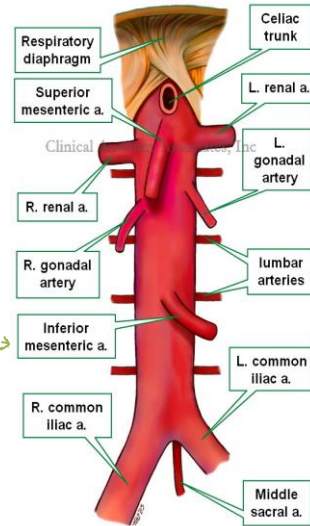
• Horseshoe Kidney (C or U shaped)

Reminder from the first Embryology lecture:

- Kidneys are formed in the pelvis and they move upwards to the abdomen
- How does 'Horseshoe Kidney' happen?
- There are *single* branches that exit the *abdominal aorta anteriorly*. The most important is the **inferior mesenteric artery**, which is the lowest of the single branches. As the kidneys ascend, it gets stuck under the inferior mesenteric artery.

Characteristics:

- Undivided in the lower pole
- Always found in the same anatomical position
- Affects 1 in 400 people
- Patient lives normally. However, due to its position, the patient may be more prone to infections.



Lower pole of kidneys
Upper poles of kidneys

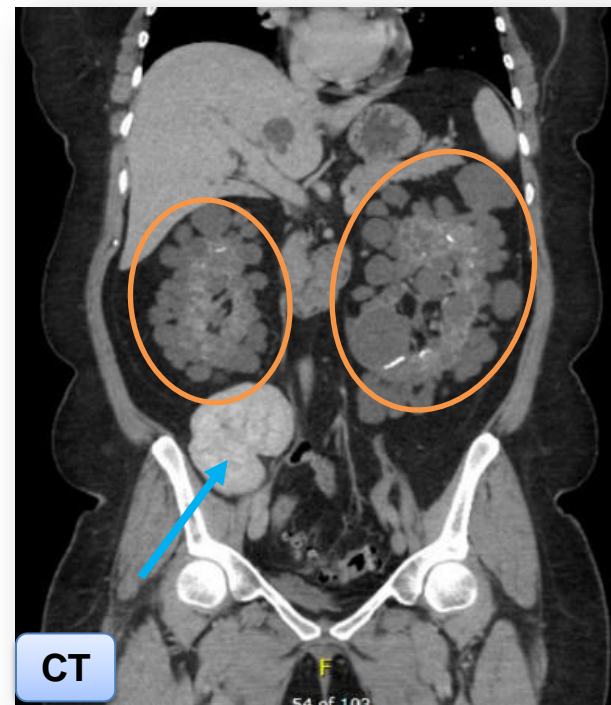
Congenital Kidney disorders

- **Polycystic Kidney Disease**

These kidneys do not affect the person. They are no longer functional and only the cysts are left. There basically a sac of fluid.

The original kidneys are not removed from the body.

Why? Because we are trying to minimise unnecessary surgical procedures.



Transplanted kidney



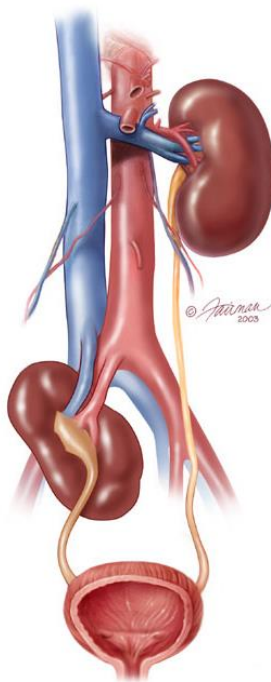
Congenital Kidney disorders

- **Ectopic Kidney**

Kidneys originate from the pelvis of the body and move upwards. However, *Ectopic Kidney* is when one fails to completely ascend and is left in the pelvic region.

Characteristics:

- Many patients live normally
- Many patients don't even know they have this condition
- It has an abnormal orientation. Therefore they may form *kidney stones* or *infections* more than others



Common Urinary Pathologies

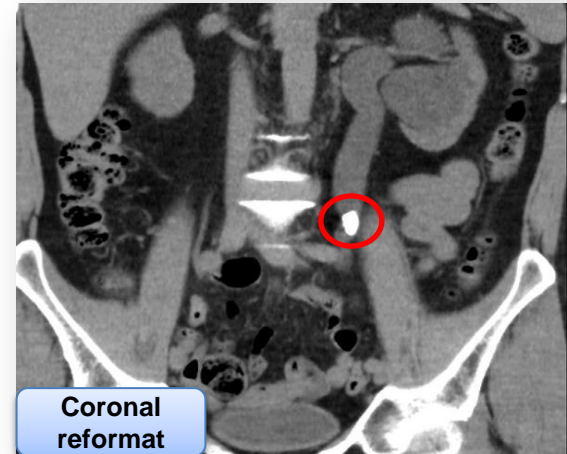
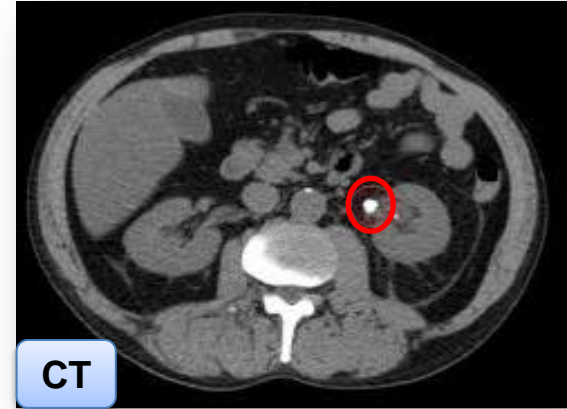
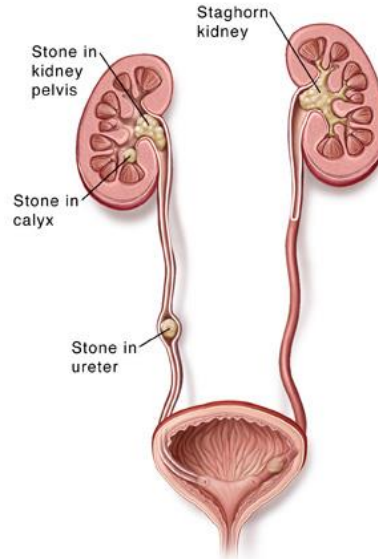


Ureter Stones

stones in the ureter will make an obstruction and block the urine's way to the bladder, which may cause Hydronephrosis.

*Coronal Reformat: a series of transverse scan images that are next to each other and recombined to produce images in a different plane such as sagittal or coronal.

بالختصار: عدة صور متتالية يدمجها بعضها البعض لتكوين صورة أخرى على محور آخر



Vesicoureteral reflux disease :

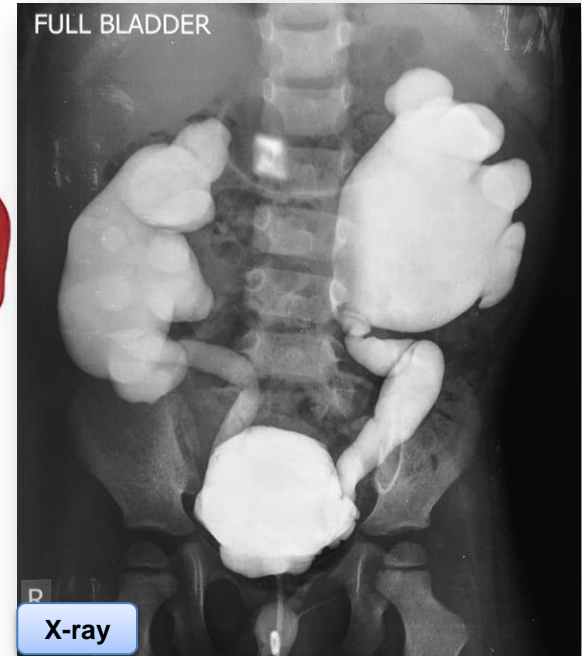
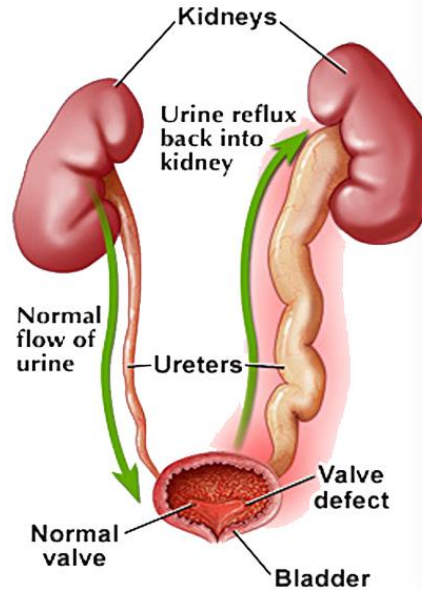
- Hydro ureter is a dilated ureter
- Hydro nephrosis is a dilated kidney

These diseases can be secondary to obstruction of the urinary tract (e.g. Ureteric Stones), or backflow.

How does backflow occur? The sphincters of the ureters that enter the bladder do not function.

- X-ray is a fluoroscopy study

What is the procedure? A catheter is put into the bladder and a contrast is injected. The contrast is supposed to collect in the kidneys, but in this disease, it moves up to the kidneys.

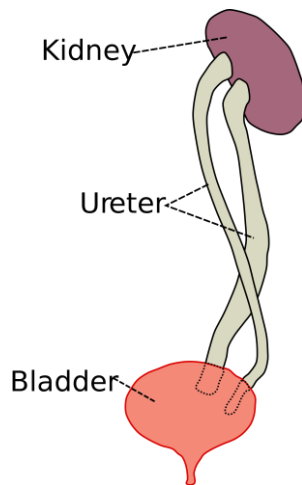


Fluoroscopy is an imaging technique that uses X-rays to obtain real-time moving images of the interior of an object. It also allows a physician to see the internal structure and function of a patient, so that the pumping action of the heart or the motion of swallowing, for example, can be watched.



Congenital Urethral disorders

- **Duplicating Collecting System.**



Common Bladder Pathologies

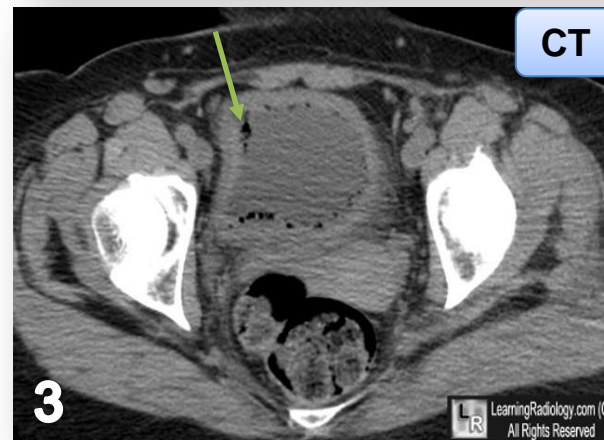
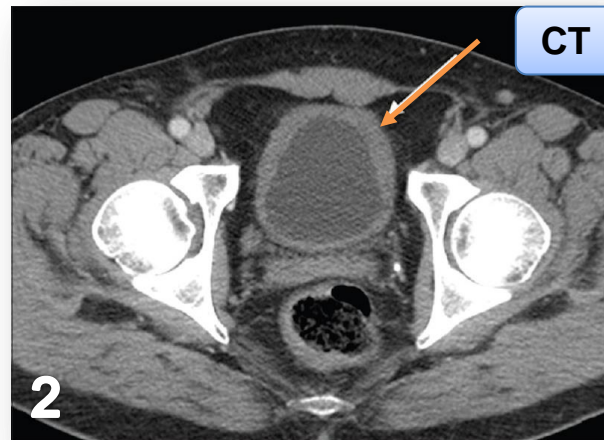


Cystitis

A bladder infection.

- Image 1: normal urinary bladder (thin surrounding wall)
- Image 2: an inflamed urinary bladder (thick surrounding walls)
- Image 3: This bladder has gas bubbles that could be due to inflammation or infection from 'gas producing' bacteria.

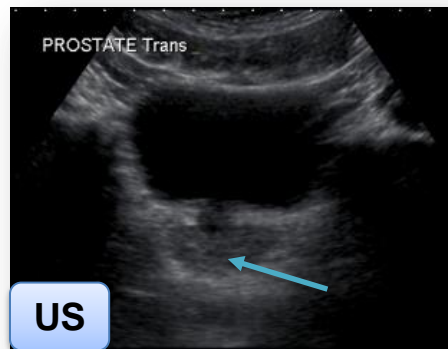
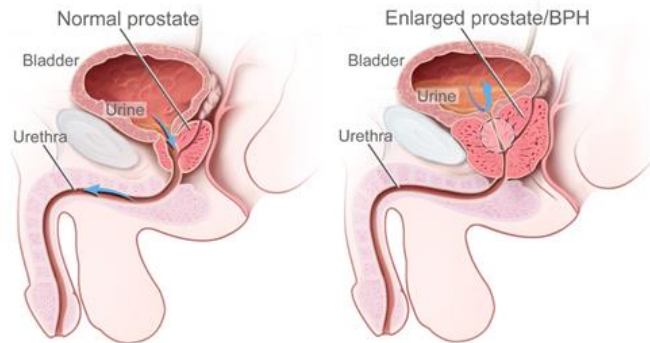
*Patients could die from this.



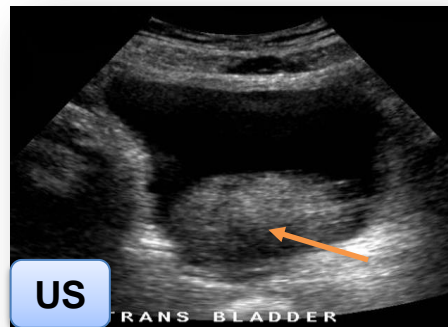
Benign Prostate Hypertrophy

The white is the contrast injected into bladder.

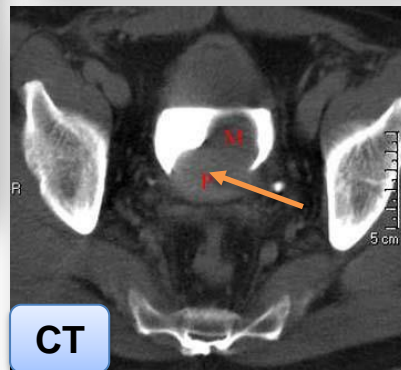
- Every male, around the age of 50, will have BPH, Cells of prostate multiply and increase in size.
- Prostate squeezes the bladder which causes the Patient to urinate frequently .
- It could cause urine dripping .



Normal



BPH

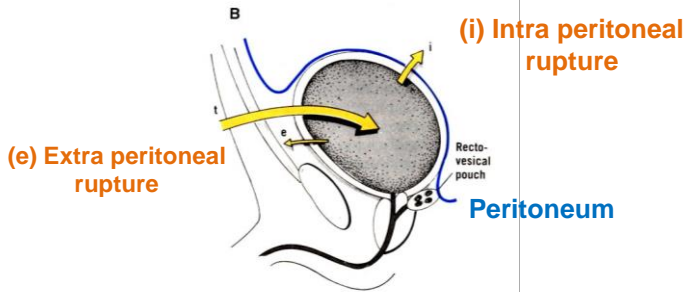
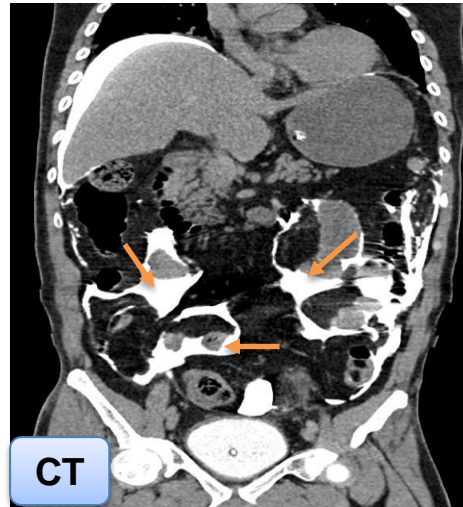


Urinary Bladder Rupture

- The abdomen is lined with the peritoneum from inside.
- The bladder is located below the membrane of the peritoneum.

Extra peritoneum: any rupture or leakage to the content of the bladder does not enter the peritoneum. Patient does not need surgery.

Intra peritoneum: there is a rupture in both bladder and peritoneum. In this case, patient will need surgery.



CT

CT

Intra peritoneum:
You can see the contrast leaking
into the peritoneum

Extra peritoneum:
The peritoneum is pushed,
but the contrast did not leak in

" وَقُلْ رَبِّي زِدْنِي عِلْمًا "

Thank you for checking our work 😊

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