

Imaging of the Renal System

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Case-1

- 35 Y old manual worker C/O
- Severe R/side loin to groin pain associated with vomiting.
- He noticed his urine colour
 - Brown/red
- UFR reveled -field full RBC
- He was sent for ultrasound



What is your probable diagnosis ?

Case-2

28 Y old newly married female
intern doctor

C/O

Fever with chills and rigors
,dysuria and increased urinary
frequency

O/E

Marked renal angle tenderness
noticed.



Case-3

- 65 Y old male
- C/O painless gross haematuria



Examination findings unremarkable

Introduction

- **What is radiology?**

It is a medical specialty that employs the use of imaging to both **diagnose** and **treat disease** within the human body.

- **What is the renal system?**

Kidneys, ureters, urinary bladder and urethra.

Imaging modalities

- Plain radiography
- Intravenous urogram / pyelogram(IVU/ IVP)
- Ultrasound (USS)
- CT
- MRI

Other specific investigations

- Angiography
- Scintigraphy (Nuclear medicine)
- MCUG
- Retrograde pyelogram
- Antegrade pyelogram
- Cystogram
- Urethrogram
-
-

Conventional radiography

- Useful as a first imaging modality.

Advantages

- Cheap ,fast, widely available.

Disadvantage

- Rarely diagnostic.
Further tests required



Conventional radiography-X Ray KUB

Image features:

- Image contrast determined by tissue density.



Clinical application

- Useful to identify radio-opaque stones
- Can measure renal sizes
- Useful in “emphysematous pyelonephritis”
(Pyelonephritis caused by gas forming organisms)

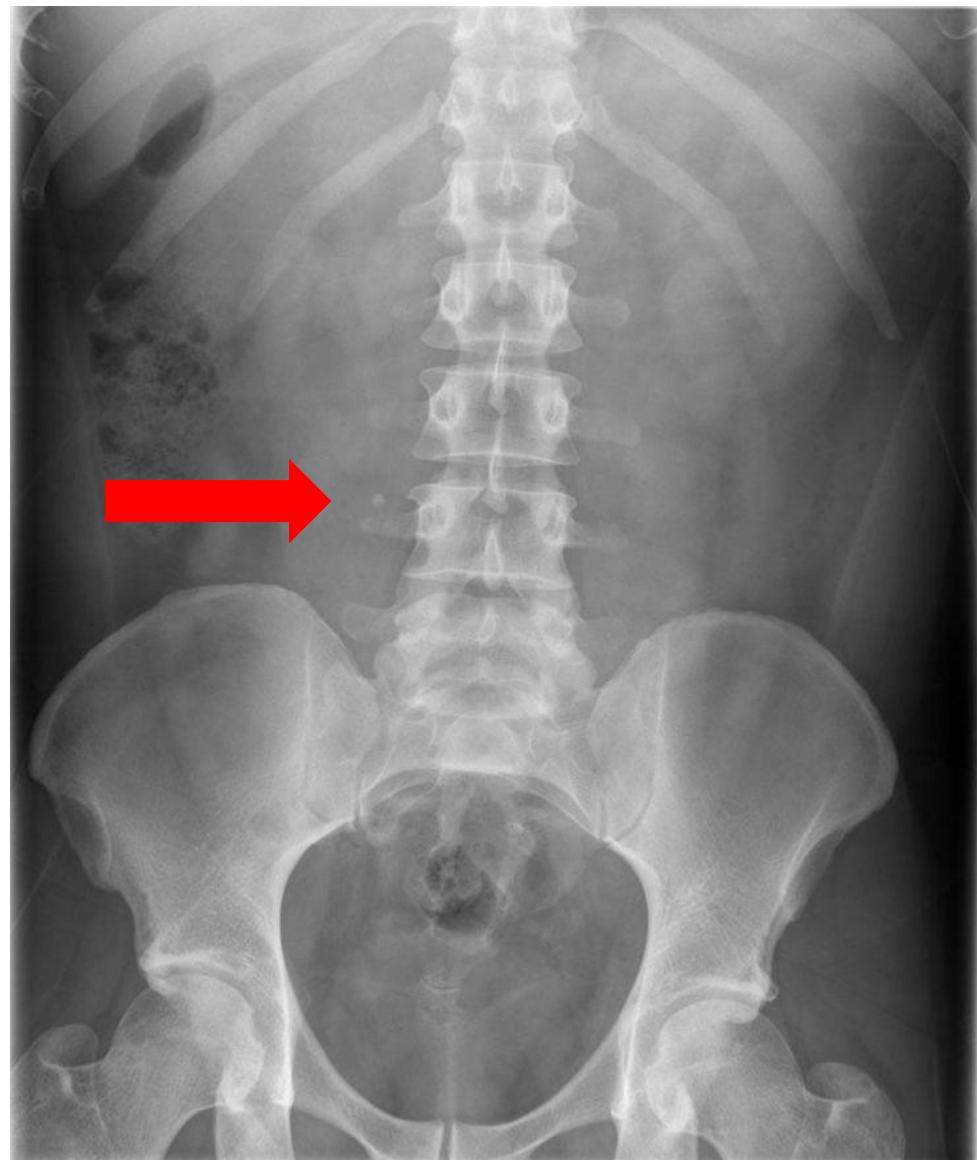
Renal calculi in X ray KUB

- Multiple renal calculi within the renal substance



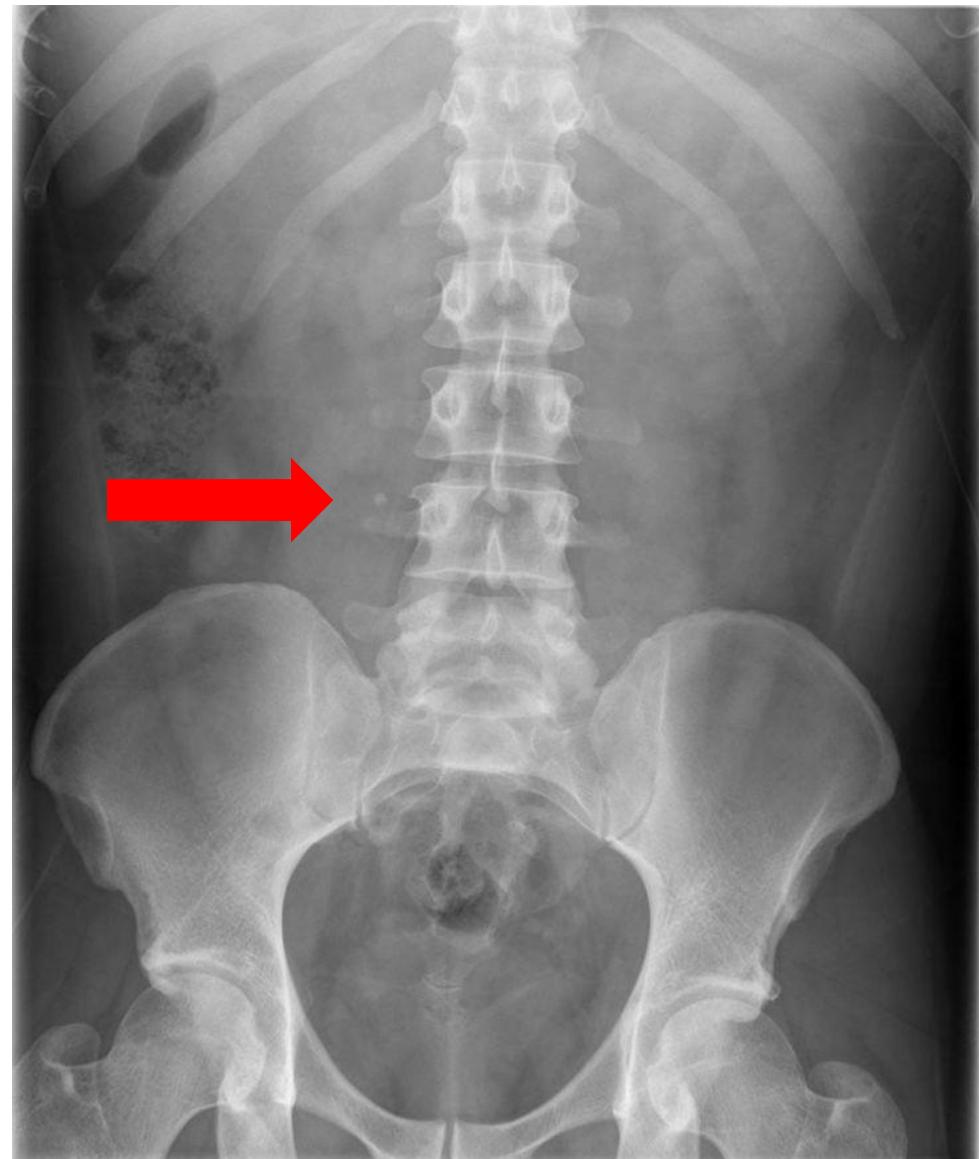
Renal calculi in X ray KUB

- Renal calculi within ureteric pathway



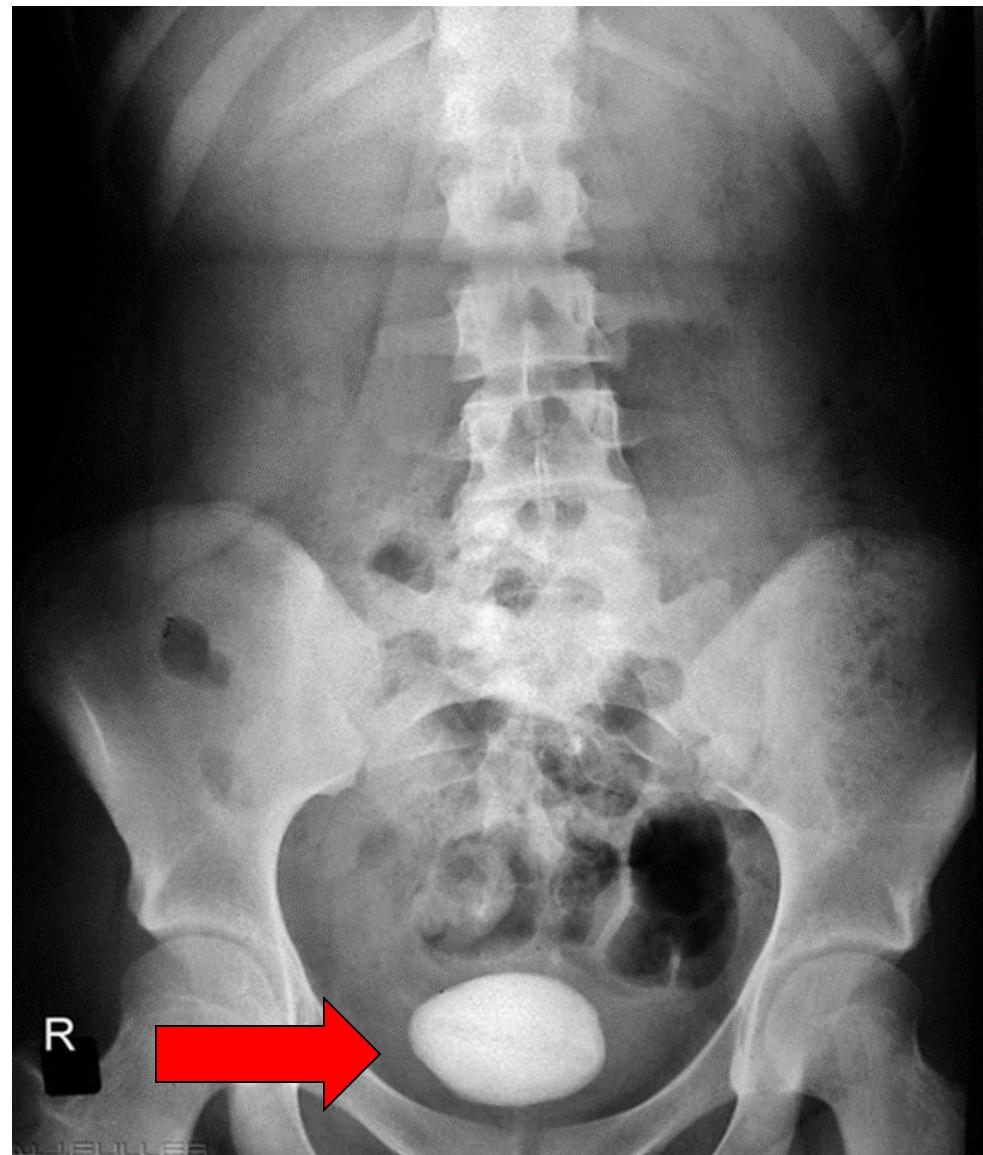
Renal calculi in X ray KUB

- Renal calculi within ureteric pathway

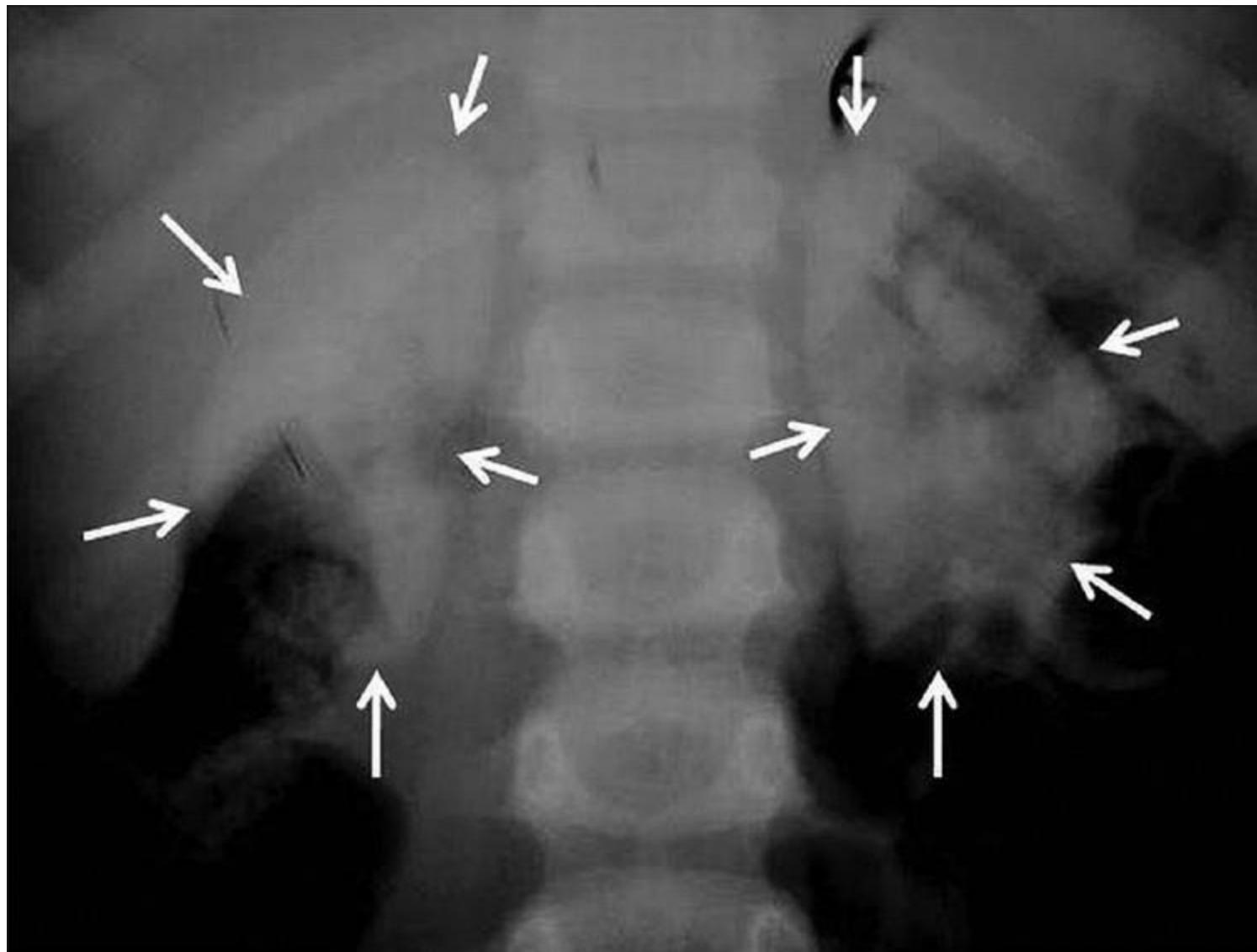


Renal calculi in X ray KUB

- Renal calculi within urinary bladder



Can measure renal sizes



Emphysematous pyelonephritis

- A morbid infection of kidneys
- characteristic **gas** formation within or around the kidneys.
- If not treated early, it may lead to fulminant sepsis and carries a high mortality.



IVU -Intravenous urogram

- Conventional x-ray plus intravenous contrast.



IVU

- Conventional x-ray plus intravenous contrast
- Gold Standard 20 years ago
- Becoming an obsolete technique
- Two dimensional technique
- Largely replaced by CT and MRI

IVU

Image features:

- Image contrast determined by tissue density and IV contrast.
- Good evaluation of collecting system and radio-opaque stones.



IVU

Advantages:

- Fast
- Widely available
- high resolution.
- Good evaluation of collecting system and radio-opaque stones.

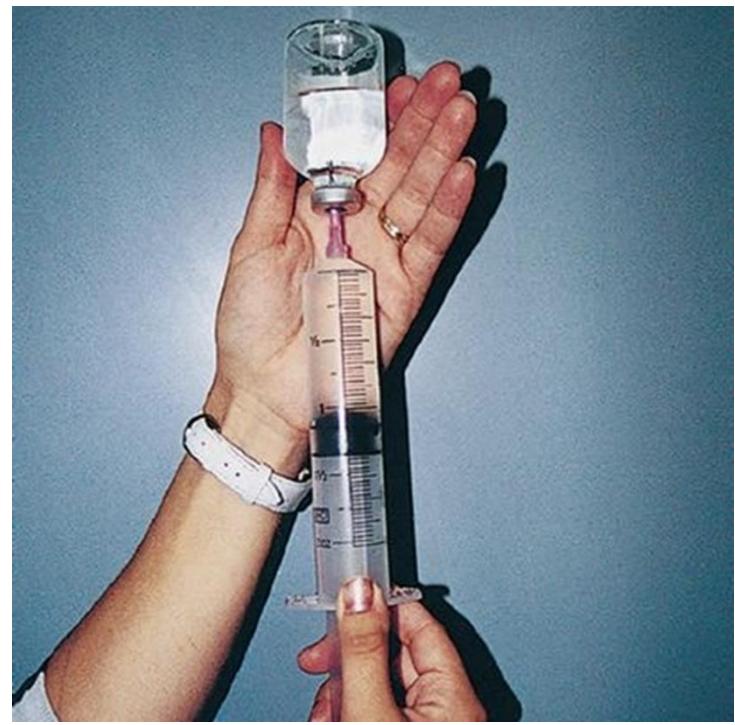
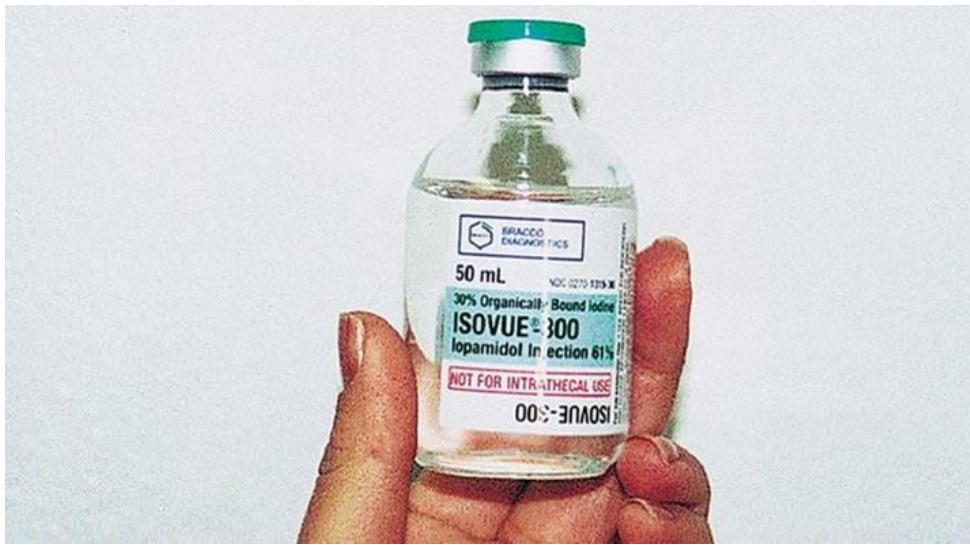
Disadvantages:

- Radiation
- Limited views of kidneys
- less specific than MRI & CT
- intravenous contrast

What is intravenous contrast ?

- Used in IVU/CT
- Highlight blood vessels and enhance the tissue structure of various organs
- Eg: brain, spine, liver and kidneys.
- "Intravenous" - contrast is injected into a vein
- Iodine containing media
- Chances to get contrast allergy in certain people (Specially if they have food or drug allergy)

What is intravenous contrast ?

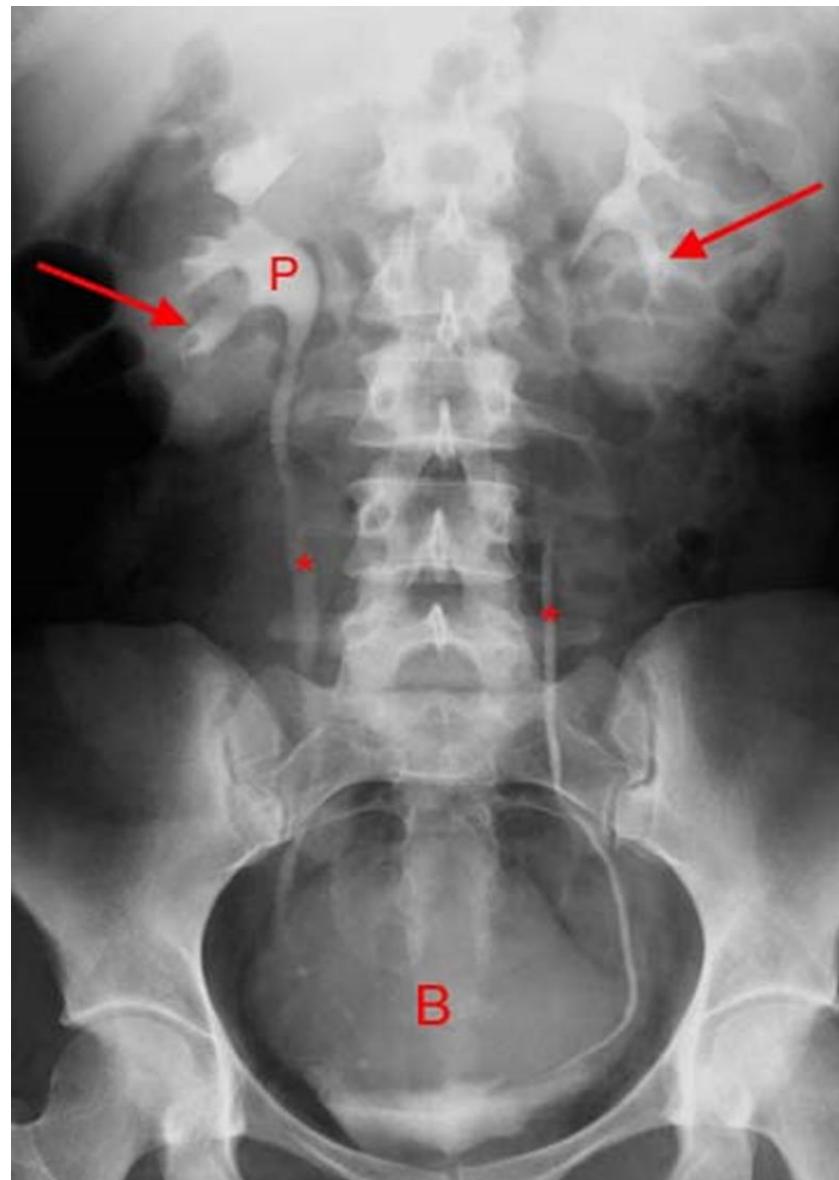


Basic films in IVU

- Plain or Control KUB image
- 0 min X-ray- renal area-nephrogram
- 5 min X-ray -renal area.-pyelogram
- 15 min X-ray full abdomen

IVU 15 min film

- Ureters projected over tips of transverse processes of L2-L5
- Turns medially at the level of ischial spine to enter bladder



Clinical application of IVU



PUJ calculus



Mid ureteric calculus

Clinical application of IVU



**Bladder
carcinoma**

ULTRASOUND SCAN

- Use high frequency sound wave.
- Contrast in the tissue/organ determined by sound reflection.



ULTRASOUND SCAN

Advantages:

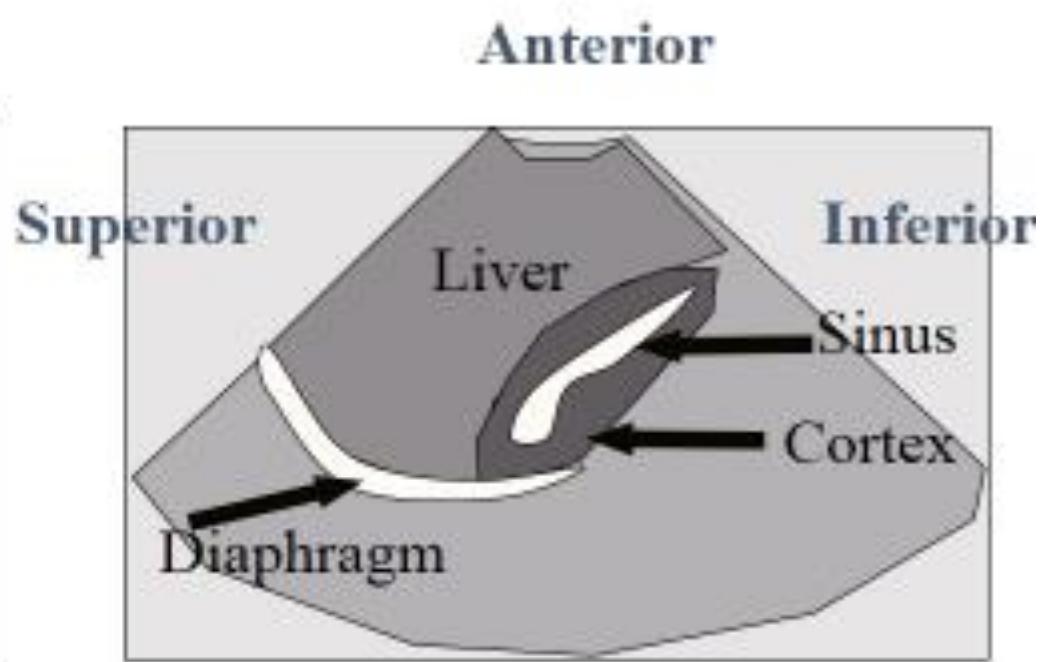
- High resolution
- non-invasive,
- widely available,
- fast.
- cheap
- Real-time assessment of blood flow (color flow imaging).

ULTRASOUND SCAN

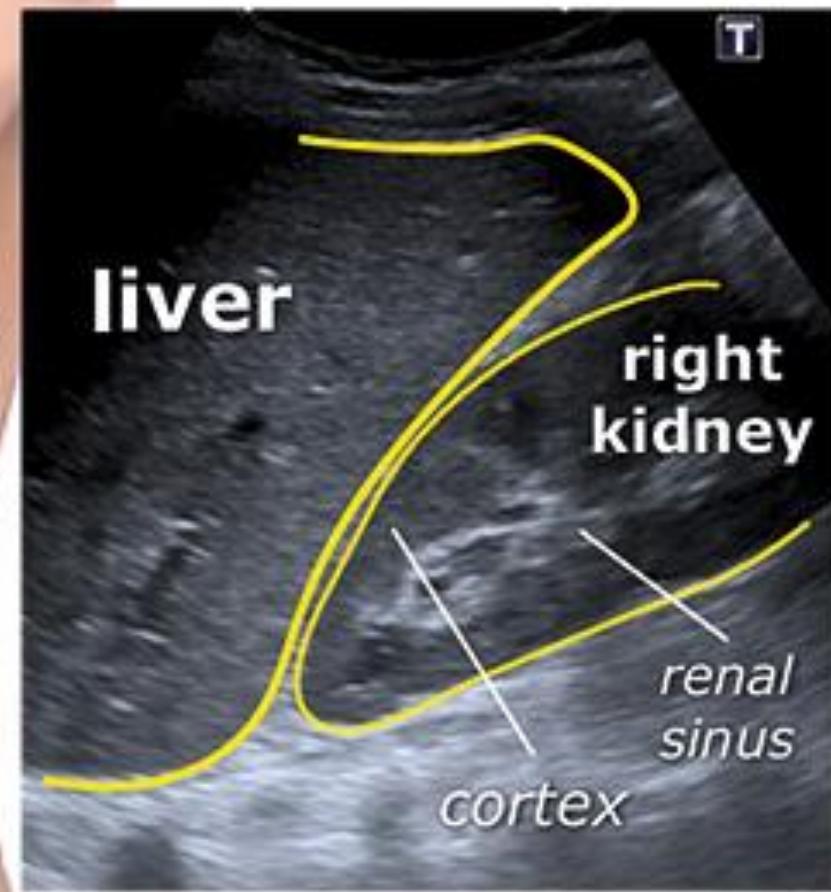
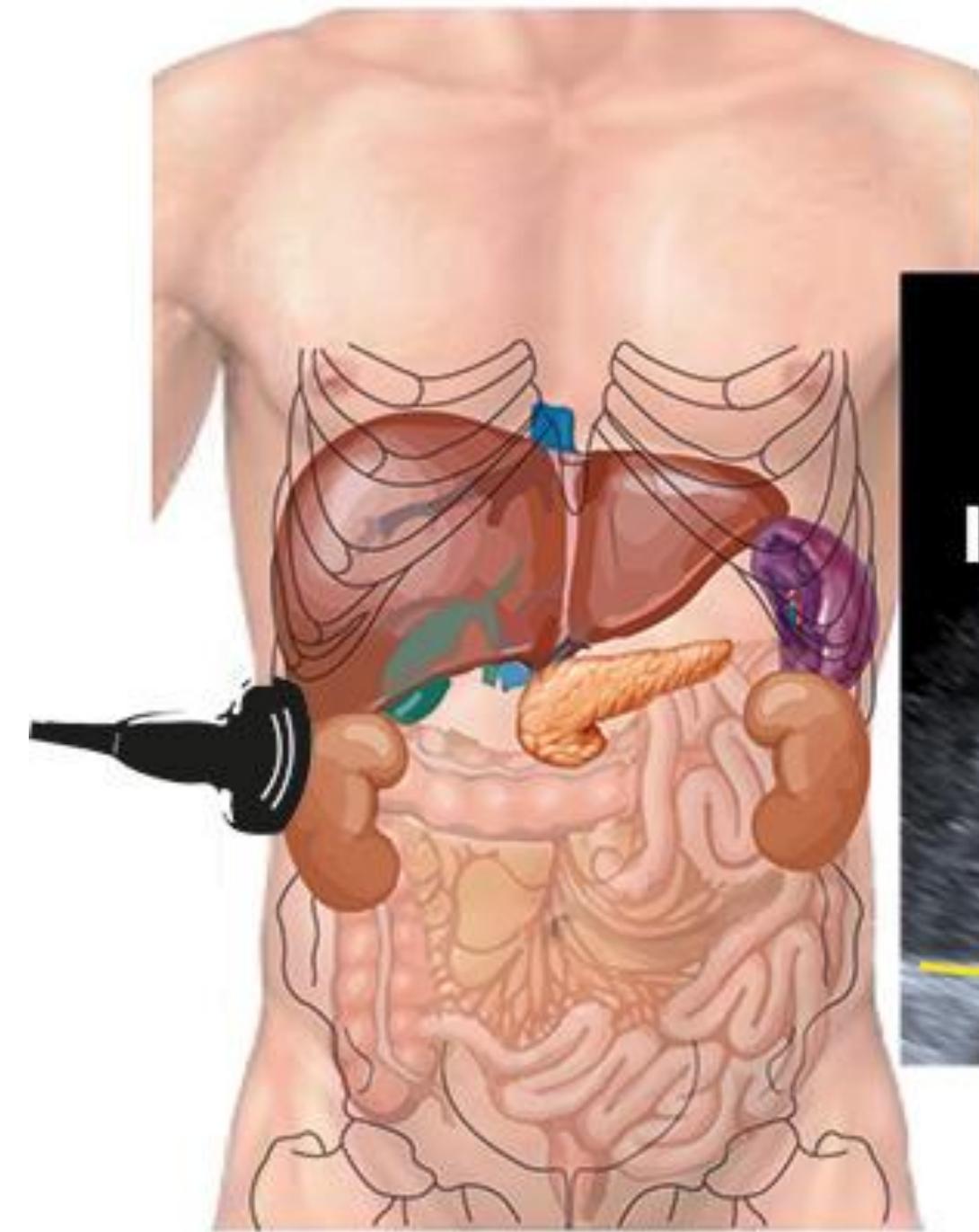
Disadvantages:

- Highly operator dependent.
- Image quality may be reduced by
 - Obesity
 - Overlying bowel gas
 - Inability co-operate with too ill patients
- Normal ureter may not be visualised.

Right Kidney Long Axis



Posterior



SA9900

Abdomen

#256 / 12.0cm MI 0.9
VA4-7 / GEN TI 0.8 02:03:35 pm
[2D] G47 / 70dB
FA2 / EE0 / P100

M

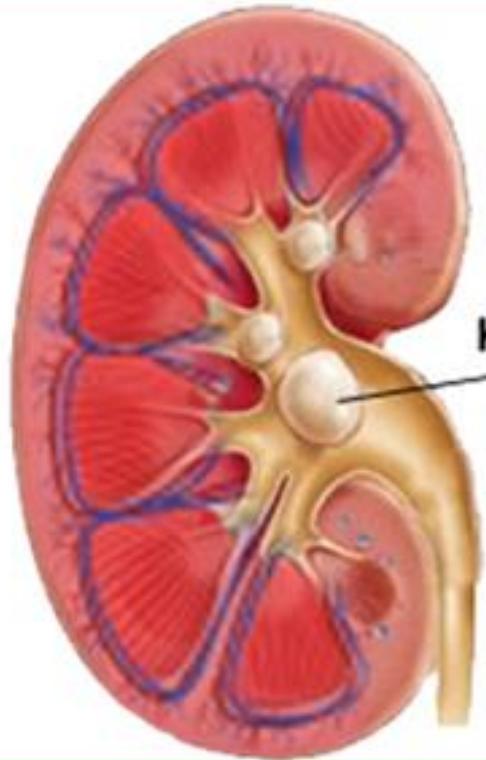


Kidney

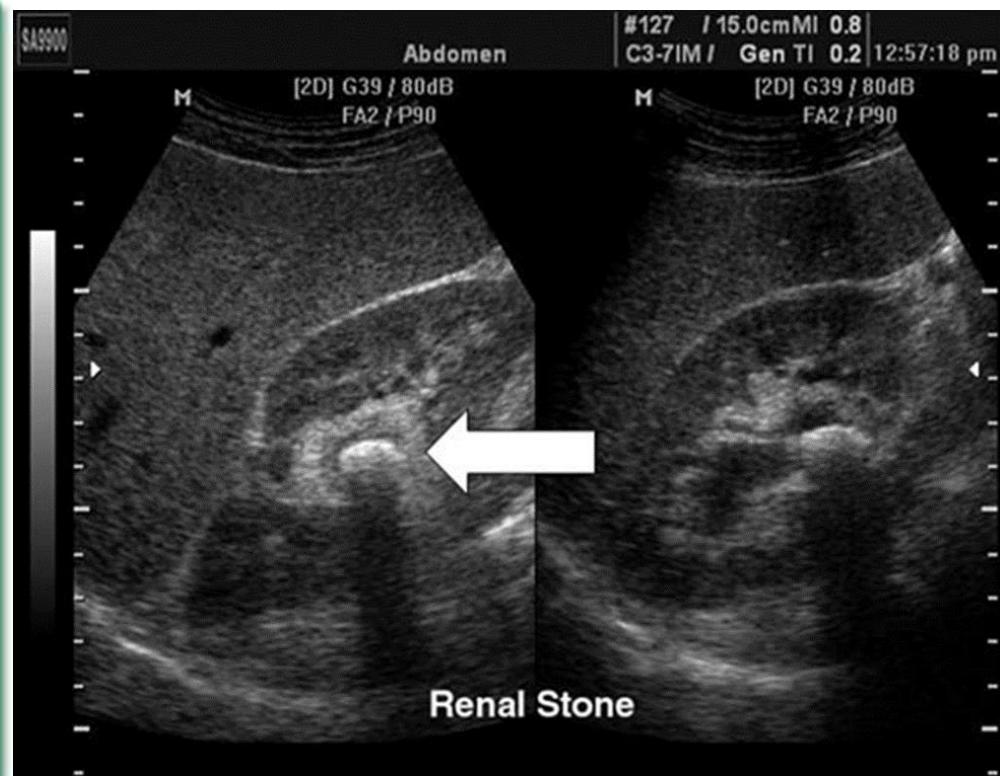
Clinical applications of USS

Renal calculi

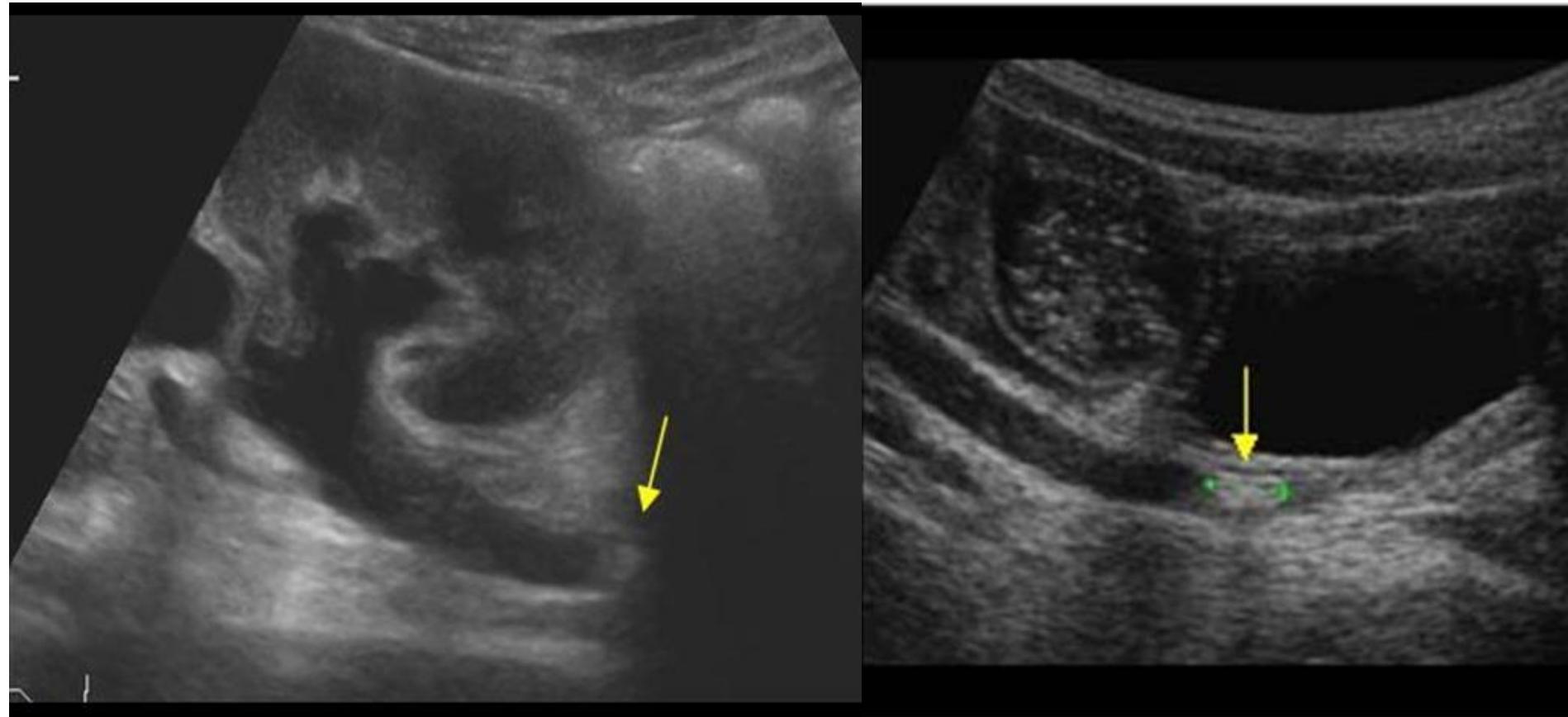
- Stones within kidney or ureter
- If within ureter –can get renal colic
- USS can use as a first line Ix
- Investigation of choice in pregnancy
- Can see bladder stones



Kidney Stones



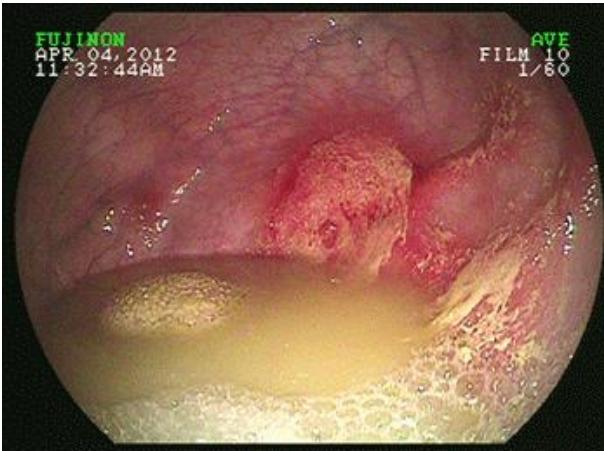
Clinical applications of USS



Upper ureteric
calculus

Lower ureteric
calculus

Clinical applications of USS



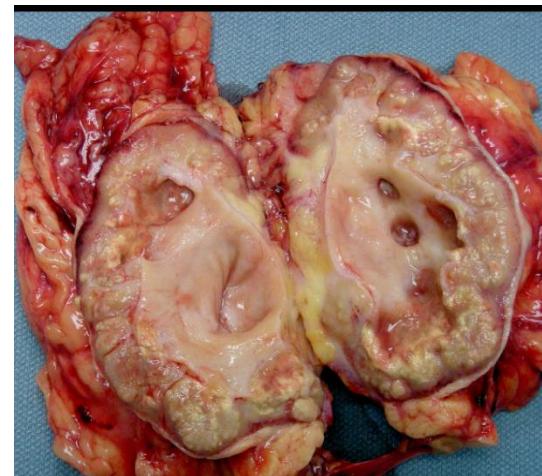
Bladder calculi

Clinical applications of USS

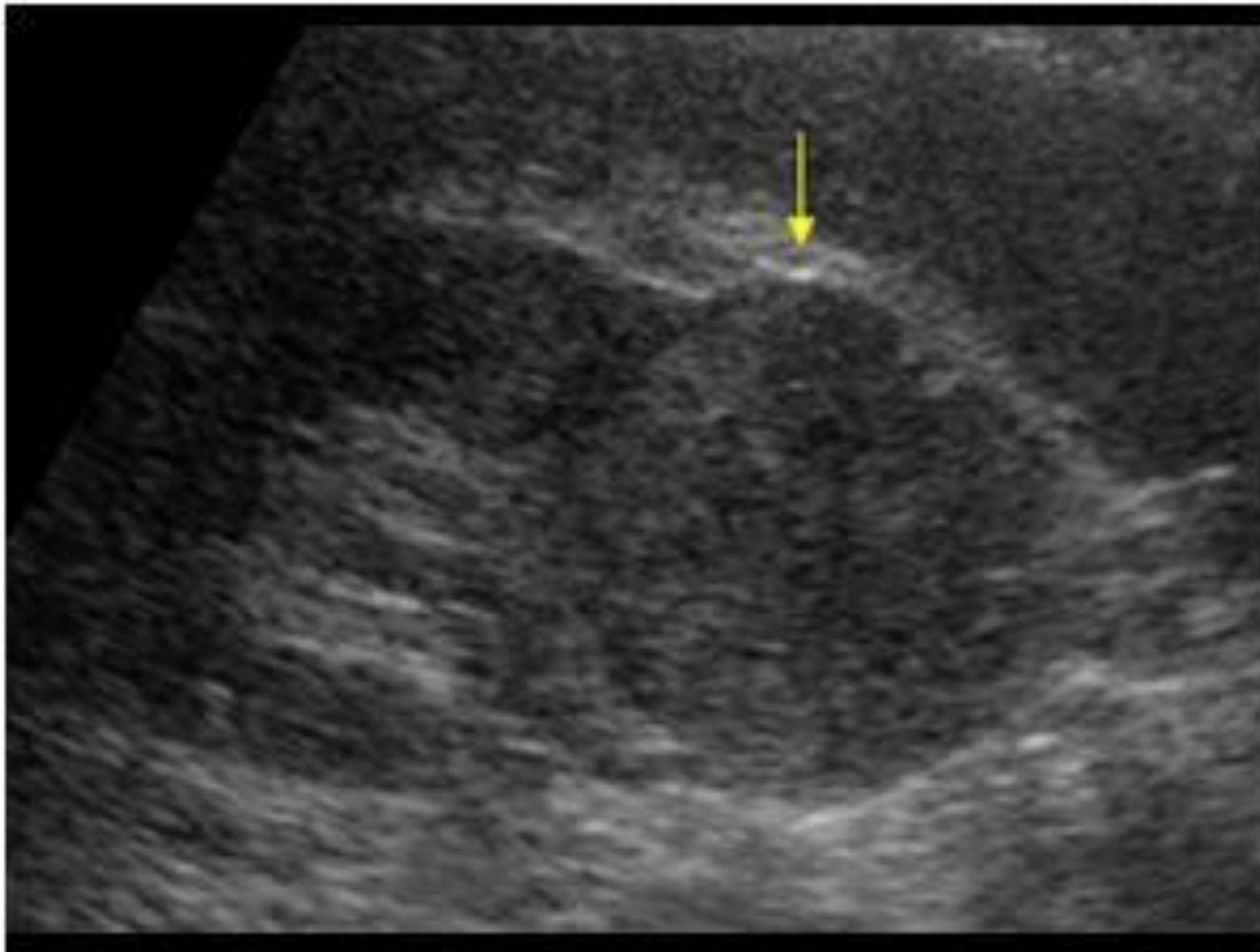
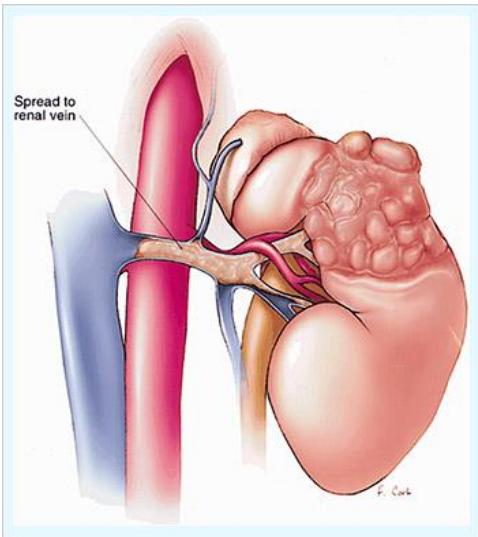
Urinary infection

- Useful to show renal size, scarring, collecting system dilatation, residual bladder volume
- To assess complications - renal / peri-renal abscesses.
- **Ultrasound is the first line investigation for UTI in children**

Clinical applications of USS



Clinical application of USS



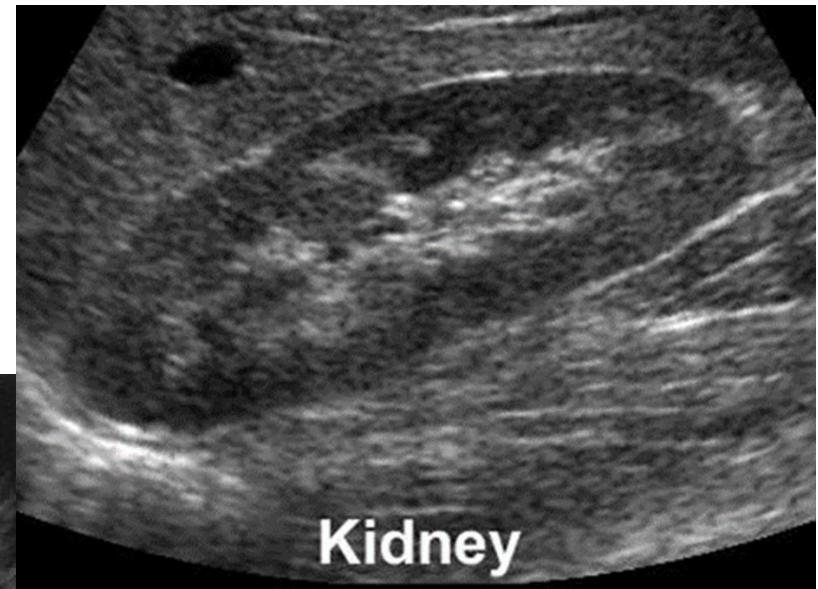
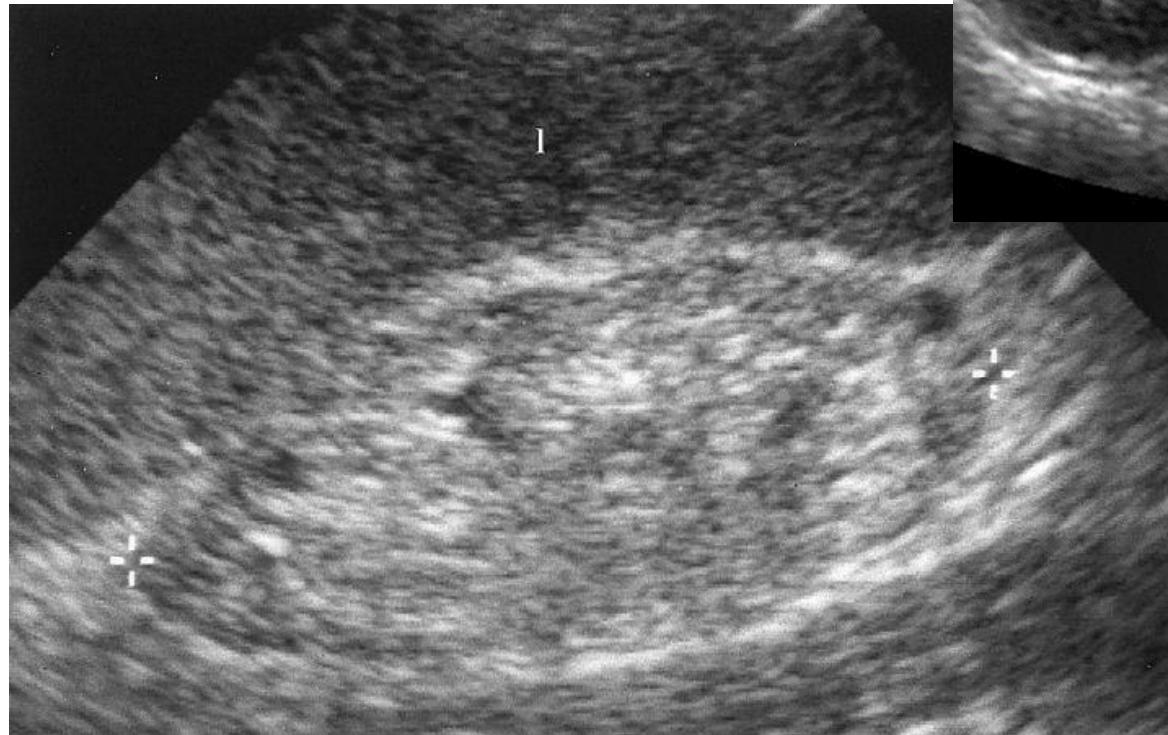
Renal cell carcinoma

Clinical applications of USS

Renal failure:

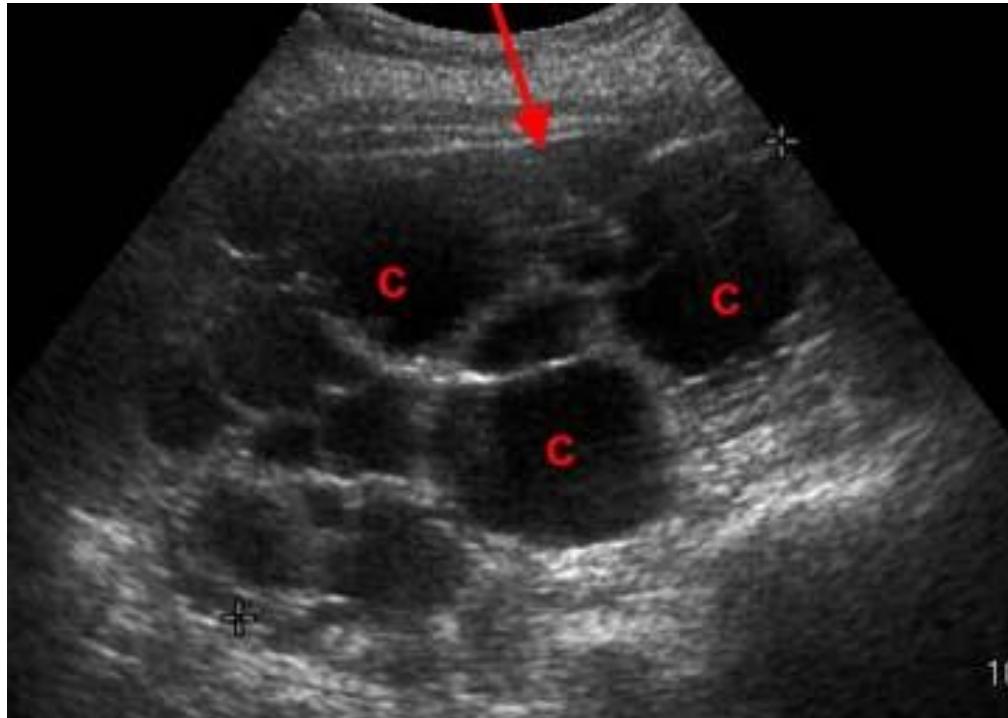
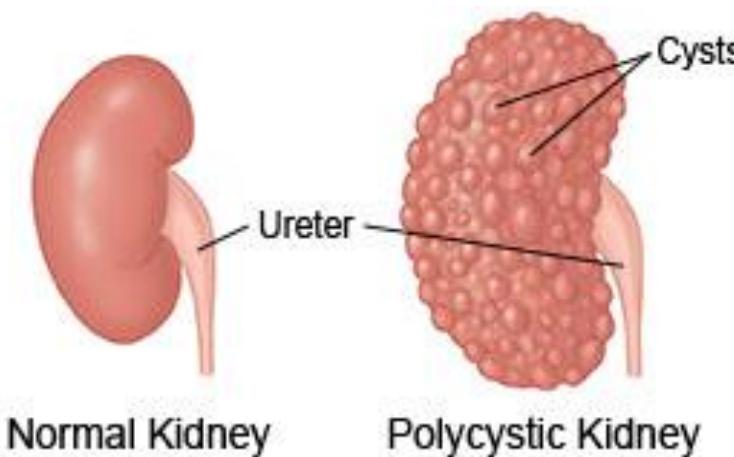
- Use ultrasound to exclude obstruction
- assess renal size (bilateral small kidneys may suggest irreversible disease)
- Check for calculi
- Polycystic kidney disease.

Clinical application of USS



Normal vs chronic renal failure

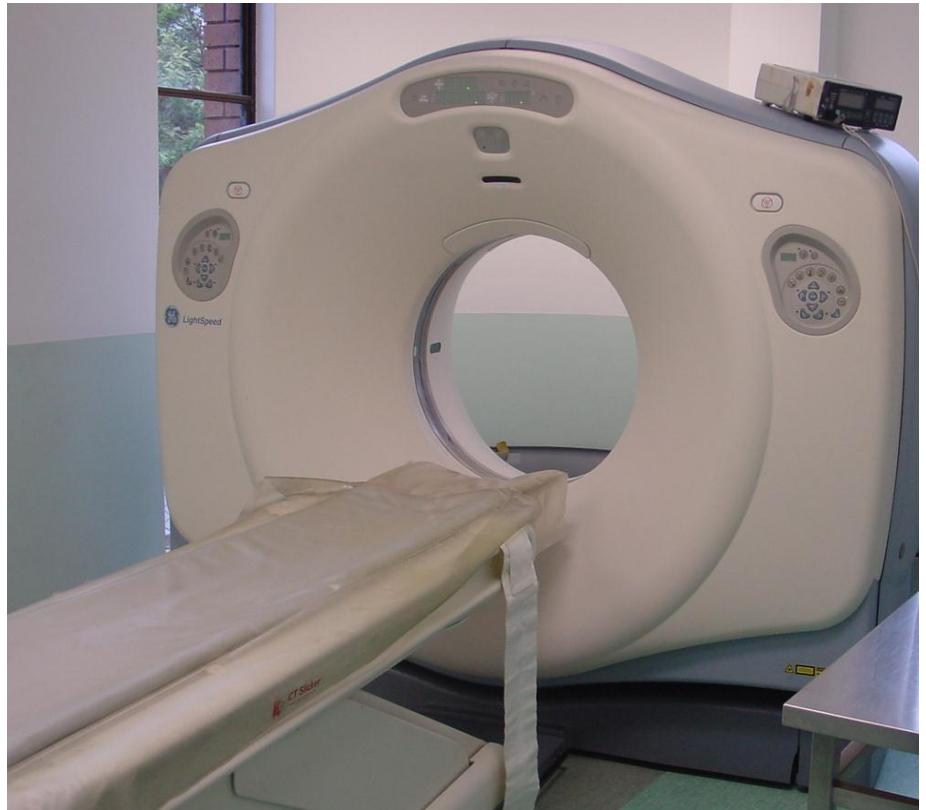
Clinical application of USS



**Polycystic kidney
disease (PKD)**

CT

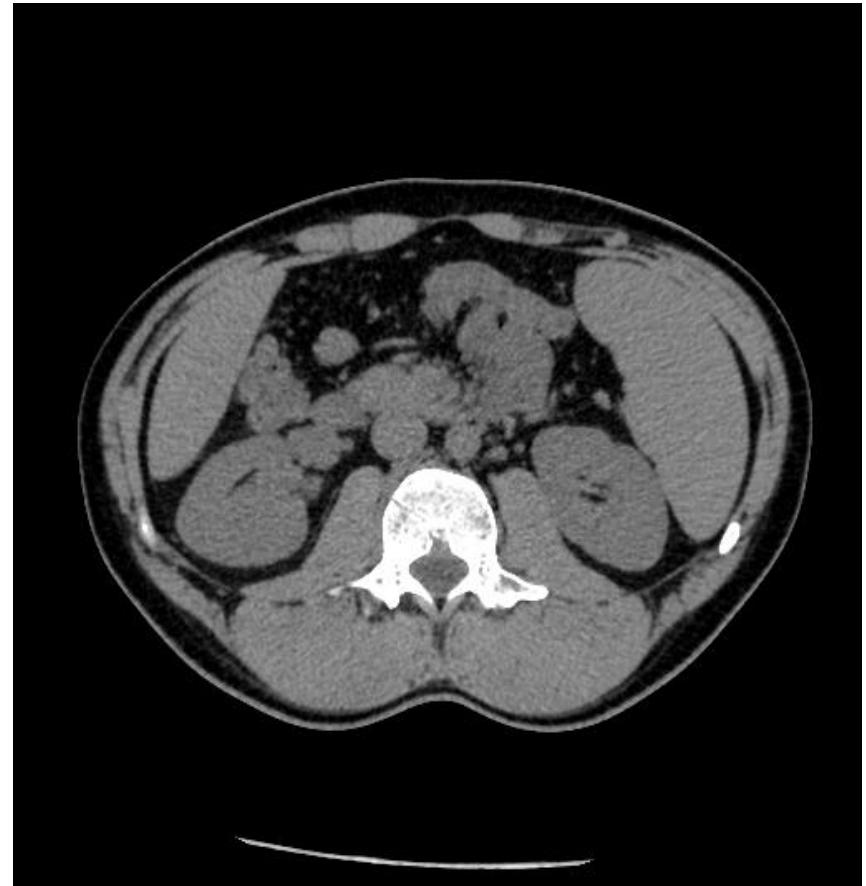
- Same basic principle as plain radiography.
- More precise.
- +/- contrast.



CT

Image features:

- Cross sectional images.
- Image contrast is determined by tissue density +/- contrast.
- Better evaluation of soft tissue and calcium.



CT

Advantages:

- Fast
- Widely available
- High resolution.

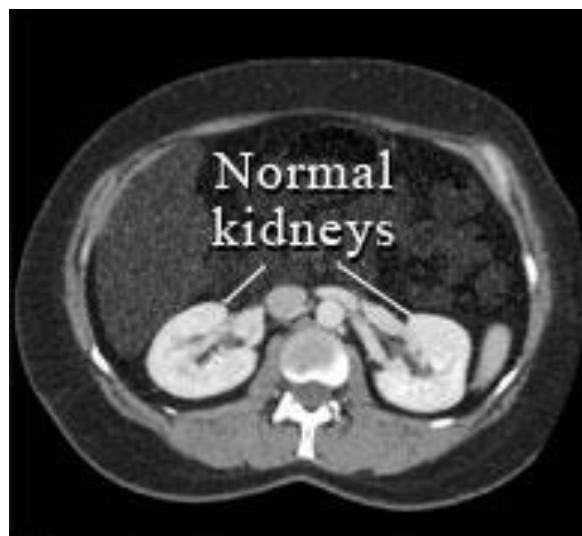


Figure 1

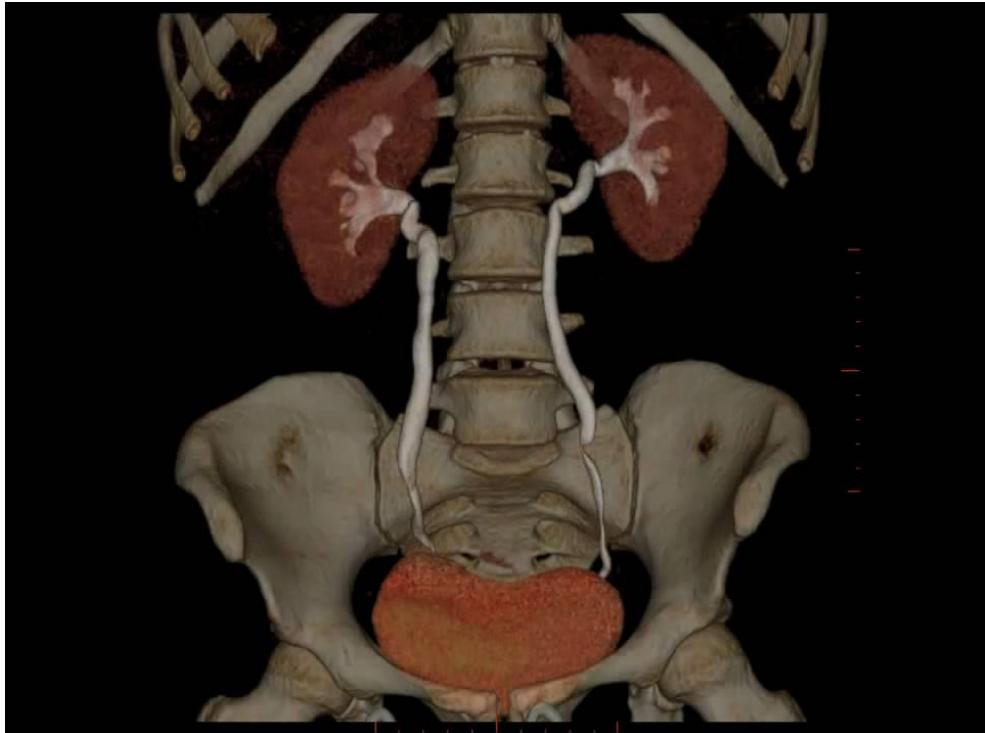


Figure 2

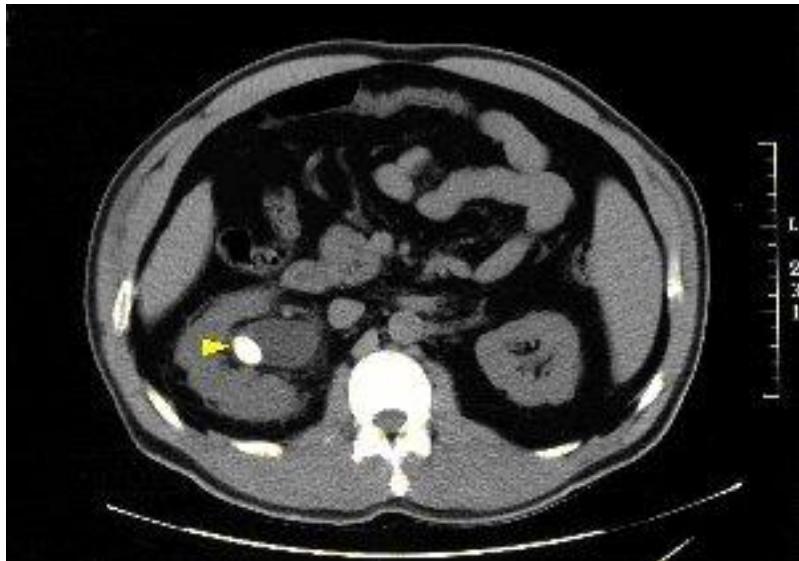
CT

Disadvantages

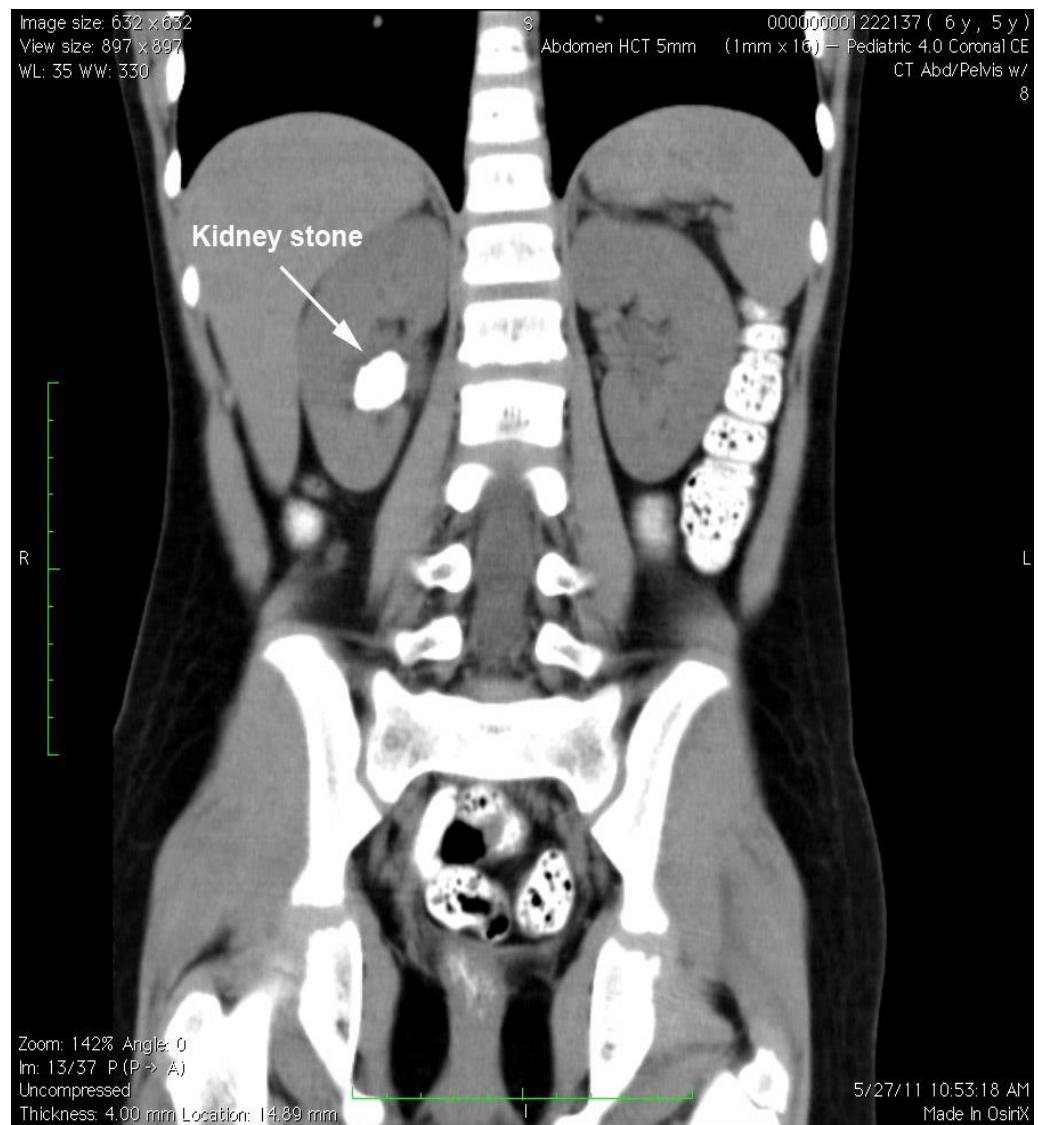
- Radiation.
- Intravenous contrast.
- Less specific than MRI.

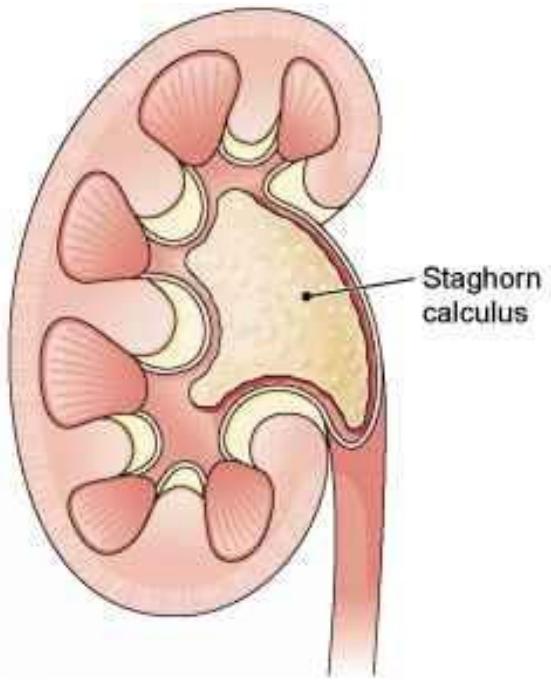


Clinical applications of CT



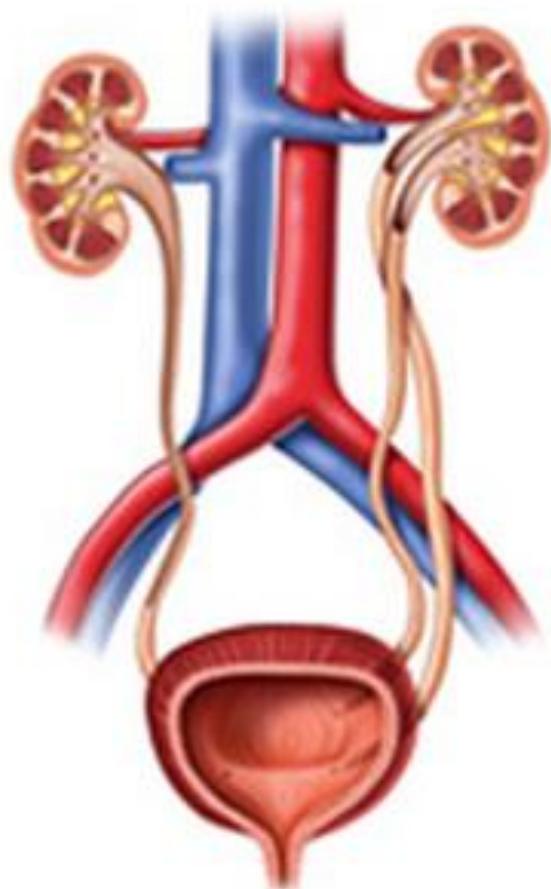
CT KUB- Renal calculi



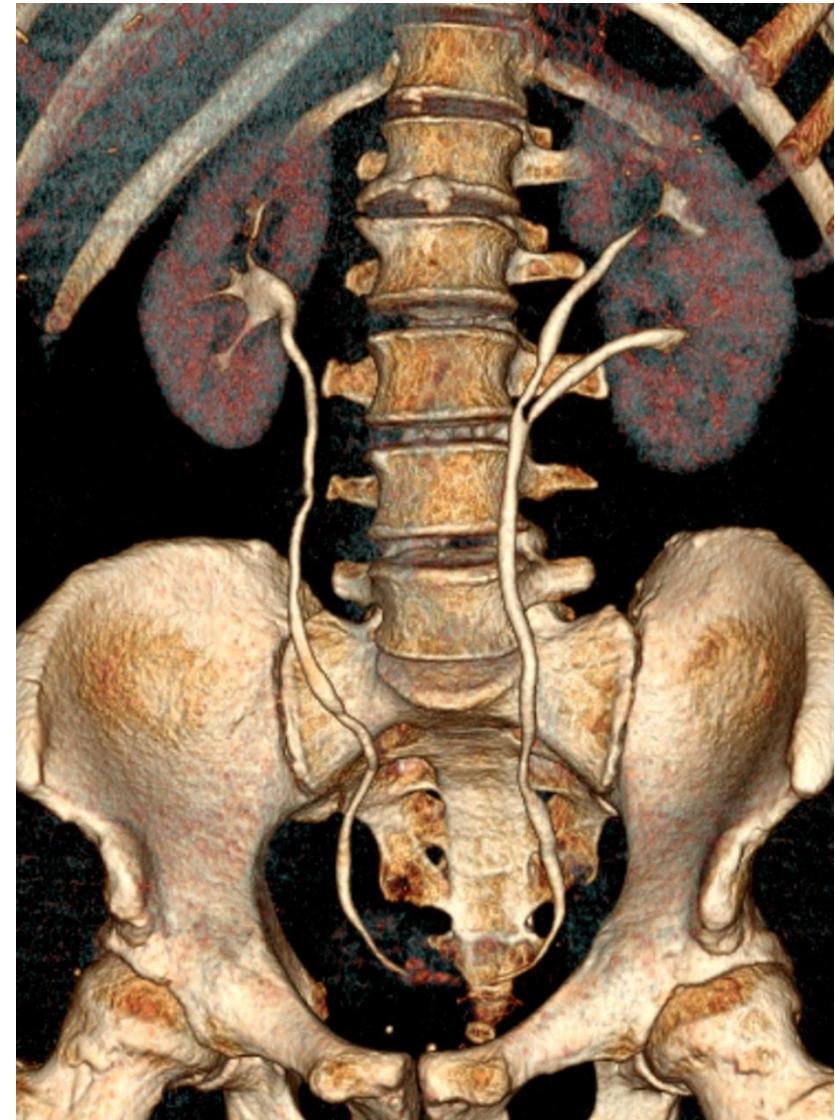


Staghorn Calculus

Clinical application of CT



Duplex system



Clinical application of CT



Intra renal abscess formation.

Clinical application of USS



Renal Trauma/ Laceration

MRI

- Better evaluation of soft tissue.
- Expensive.
- Useful for soft tissue pathology: tumor, infection.



MRI

Advantages:

- Many imaging sequences (Eg T1W,T2W.....)
- No radiation,
- More specific than CT
- Excellent for soft tissue evaluation

MRI

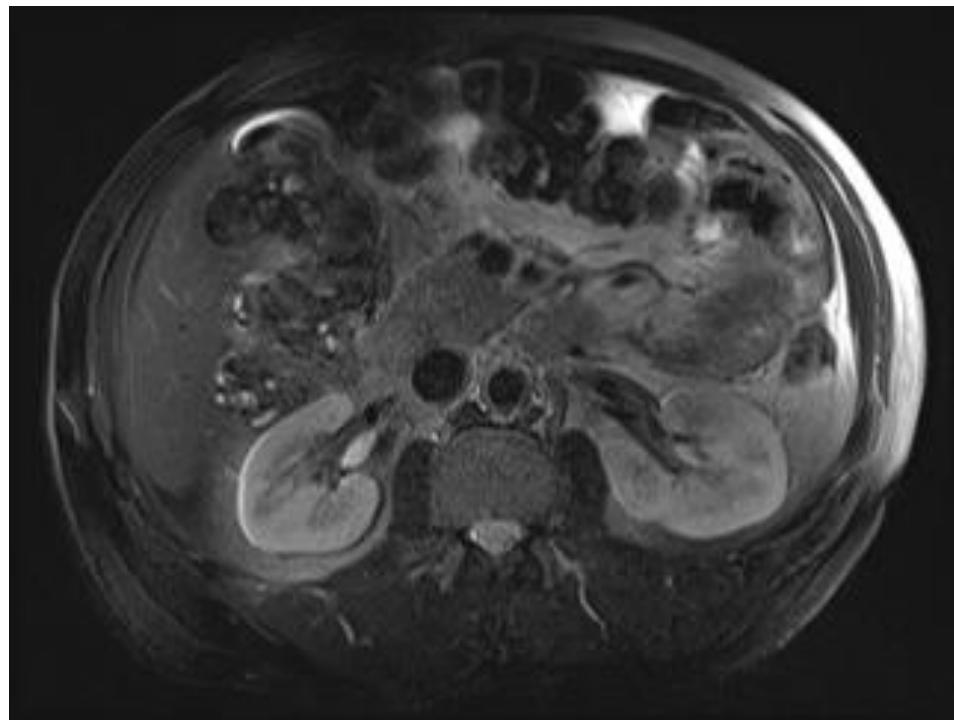
Disadvantages:

- Cost
- Longer imaging times than CT.
- Unable to imaging calcium
(renal/ureteral calculi, calcifications)

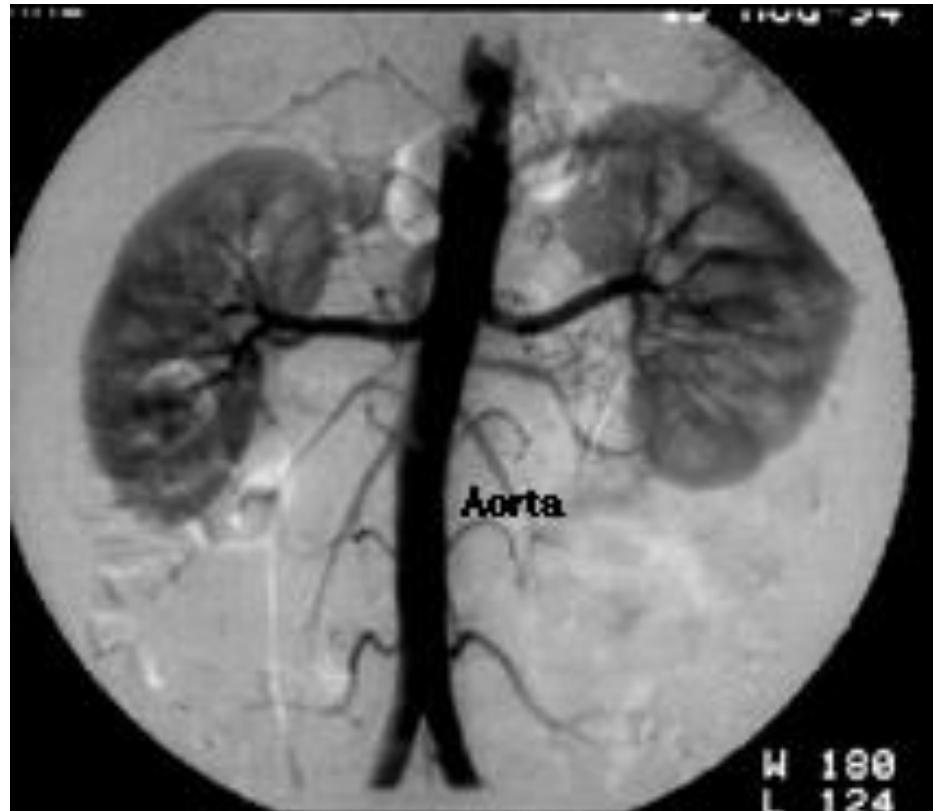
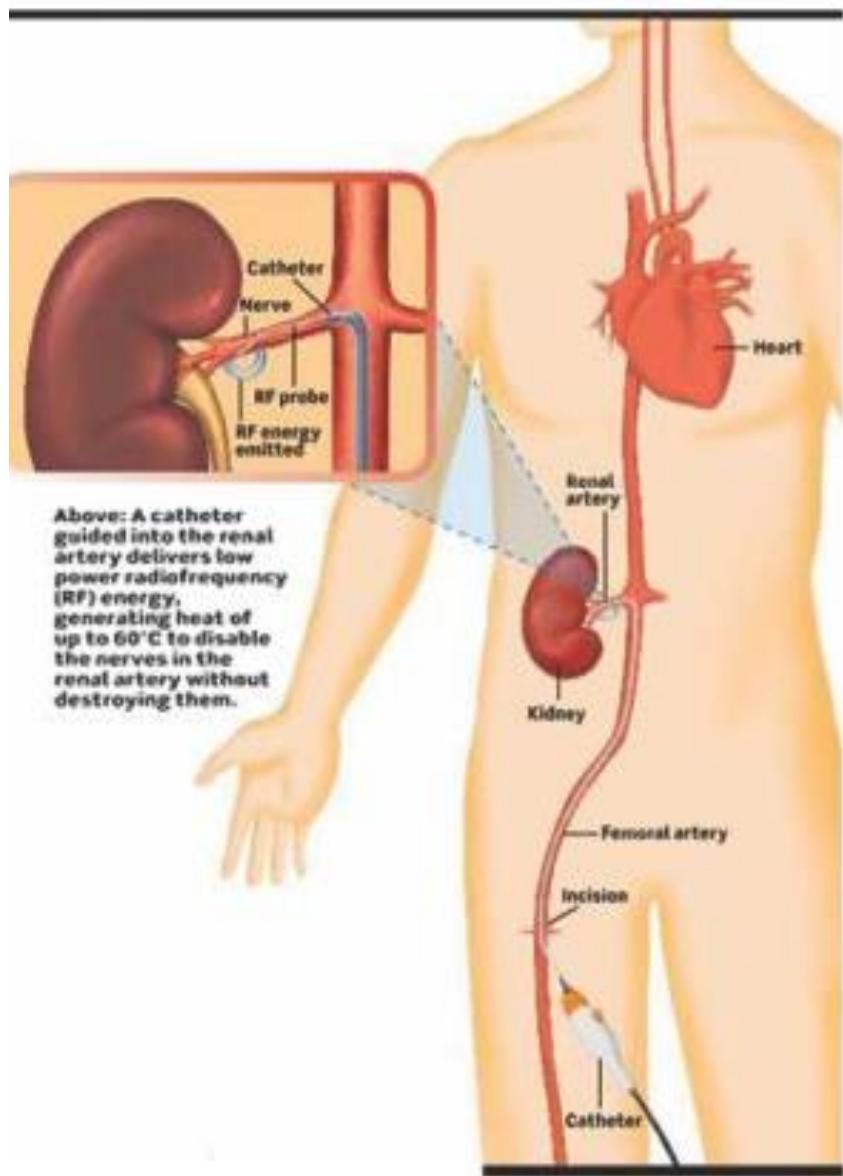
MRI

Image features:

- Cross sectional images.
- Image contrast determine by tissue properties.

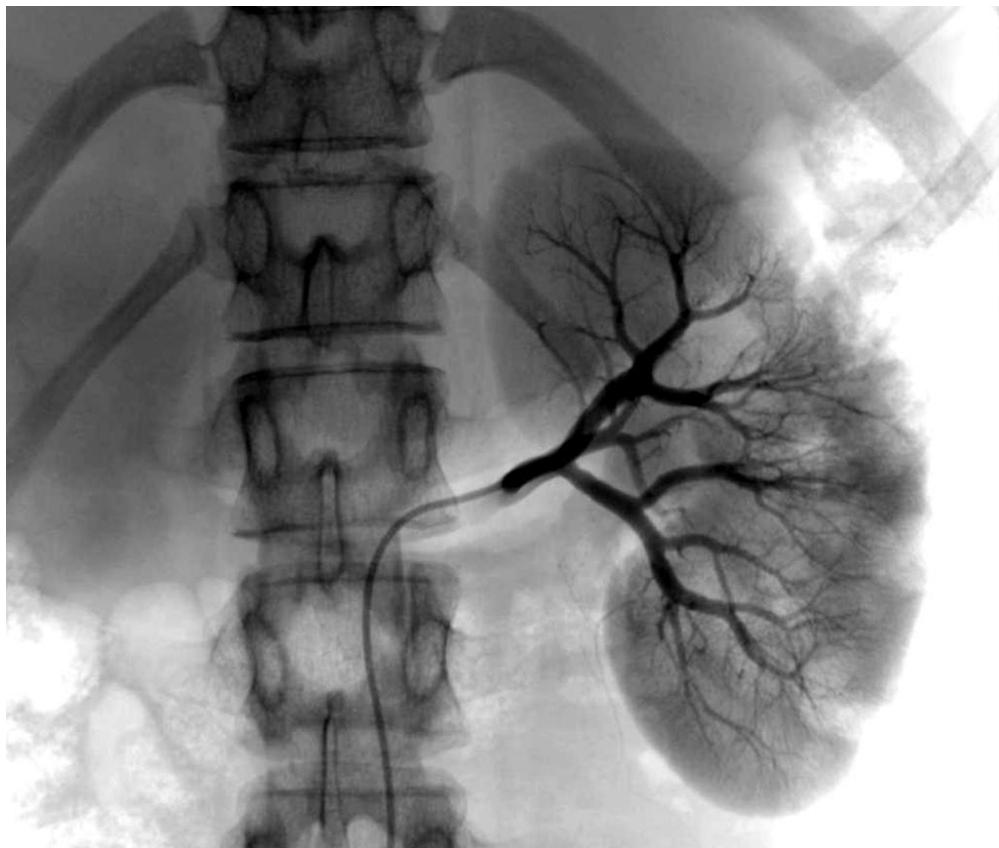


Renal angiogram

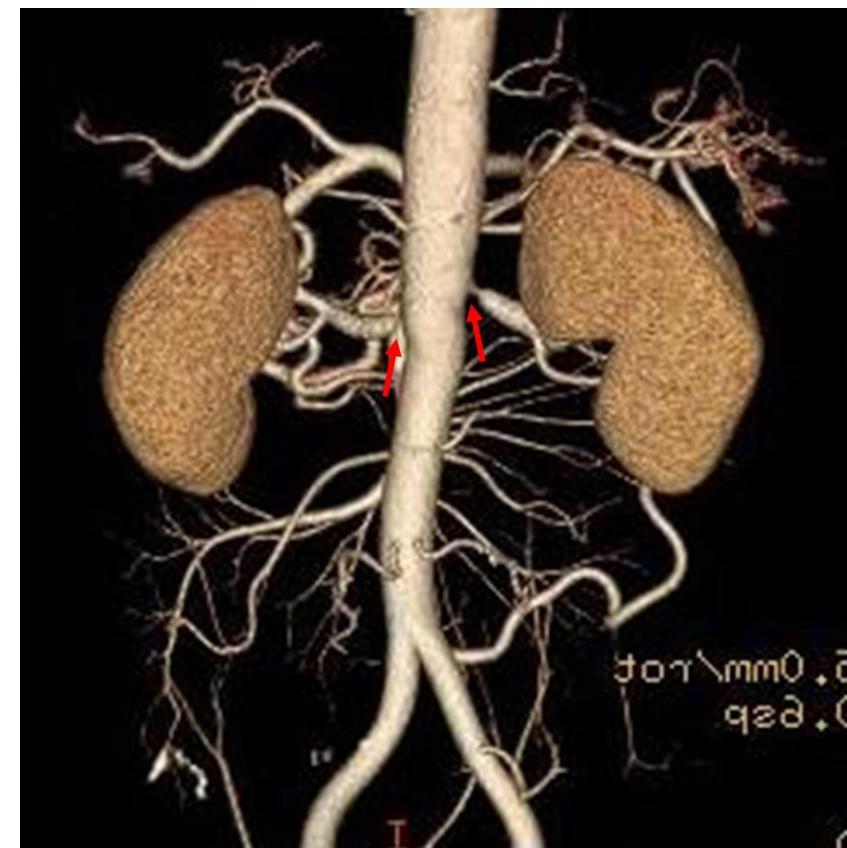


A Catheter is placed in mid aortic level

Renal angiogram



Conventional angiogram



CT angiogram

Nuclear medicine

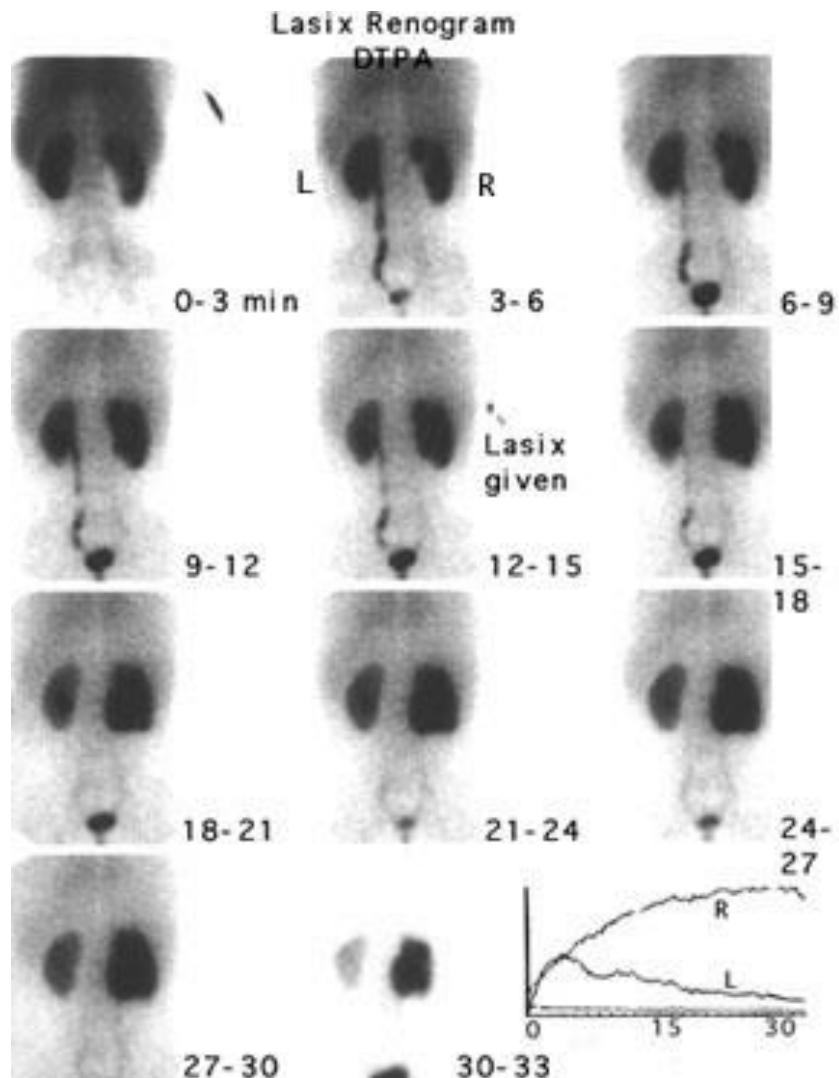
- Utilizes a gamma camera and radioactive isotopes.
- Functional test.
- Less expensive.
- Useful for:
obstruction and split function.



Nuclear medicine

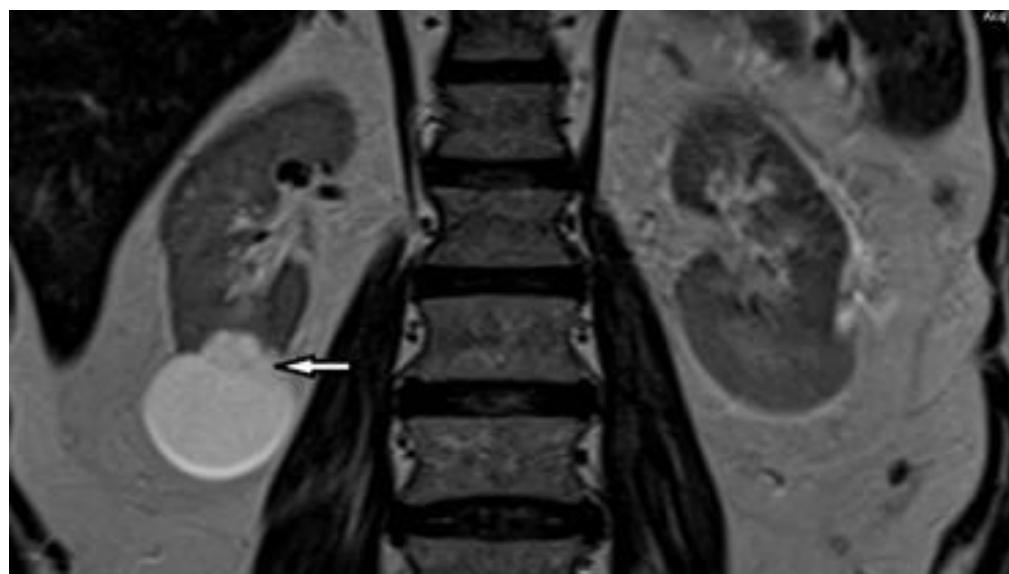
Image features:

- Projectional image.
- Image contrast depend on tissue uptake and metabolism.



99mTc-DMSA scintigraphy

- Uses dimercaptosuccinic acid as a drug
- Attached to 99m Tc(as a radioactive tracer)
- Given via IV route
- Emitting gamma rays are detected by a Gamma camera

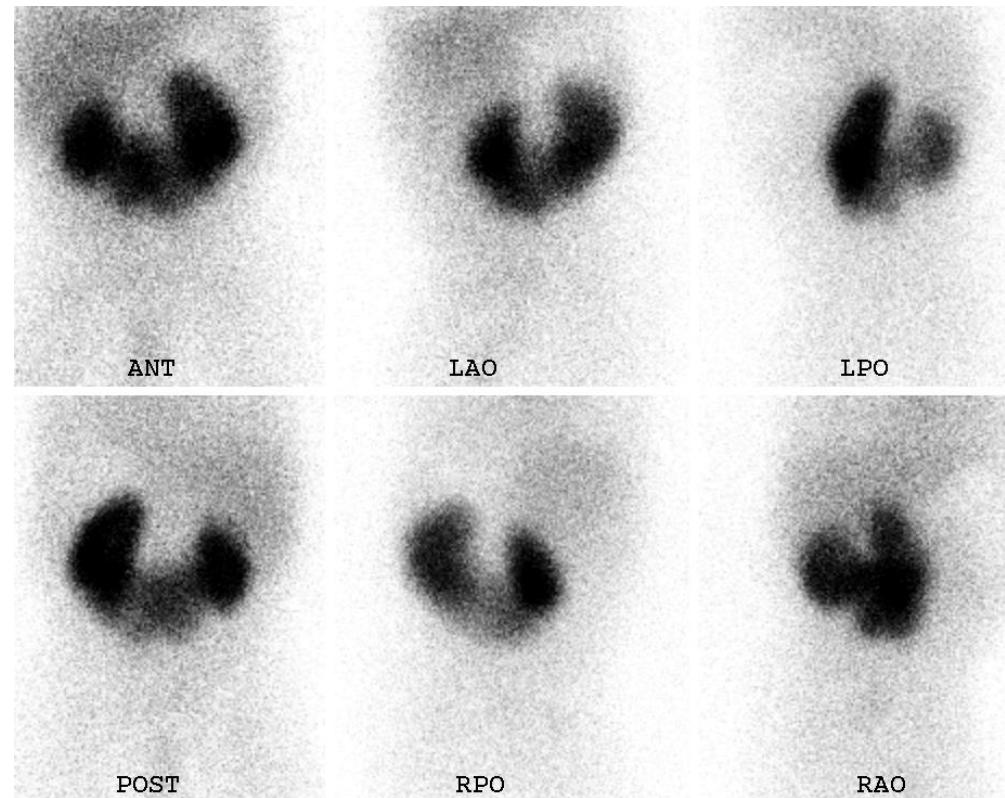
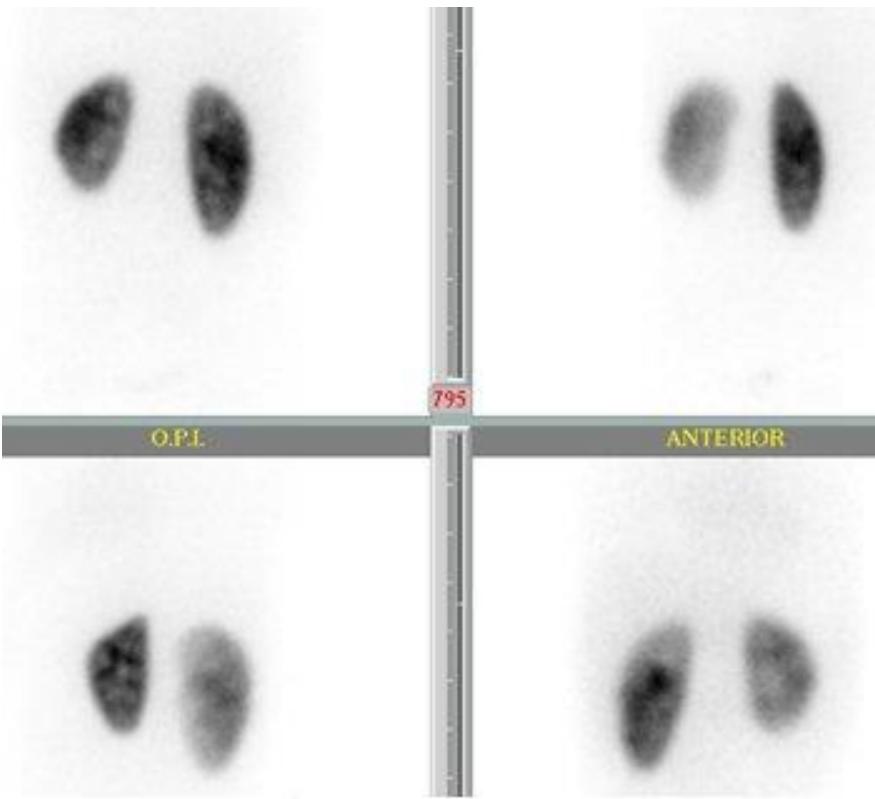


99mTc-DMSA scintigraphy

Indications

- Detection of focal renal parenchymal abnormalities
- Detection of acute pyelonephritis.
- Detection of associated abnormalities: abnormal duplex kidney, small kidney
- Detection of ectopic kidney
- Confirmation of non-functional kidney.

99mTc-DMSA scintigraphy



Horseshoe kidney

99mTc-DTPA scintigraphy

- Diethylenetriaminepentaacetic acid (DTPA)
- Attached to isotope 99m Tc
- Given via IV route
- Emitting gamma rays are detected by a Gamma camera

99mTc-DTPA scintigraphy

Indications

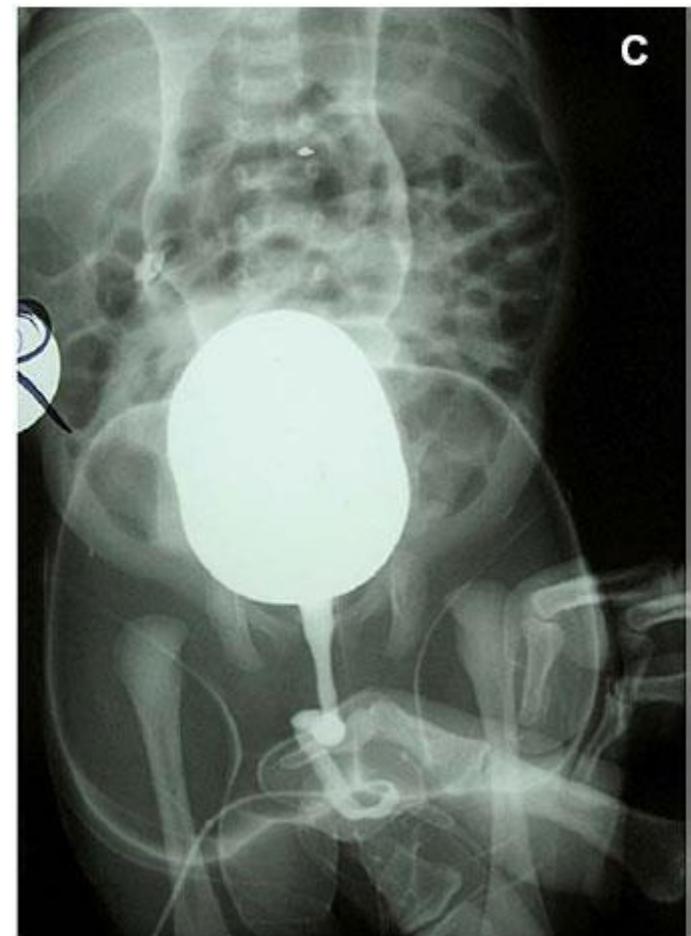
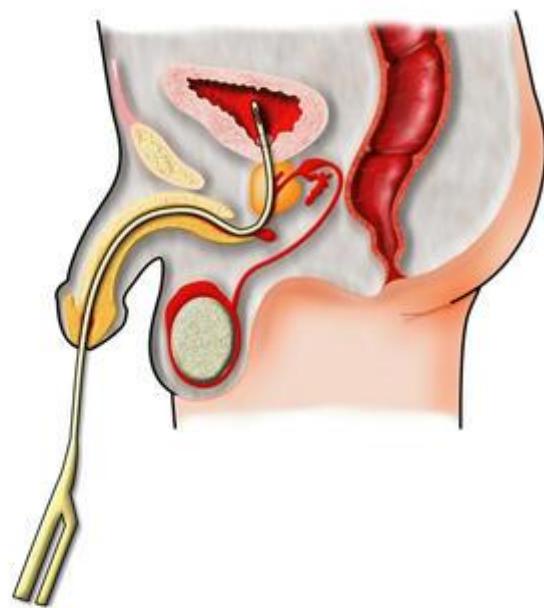
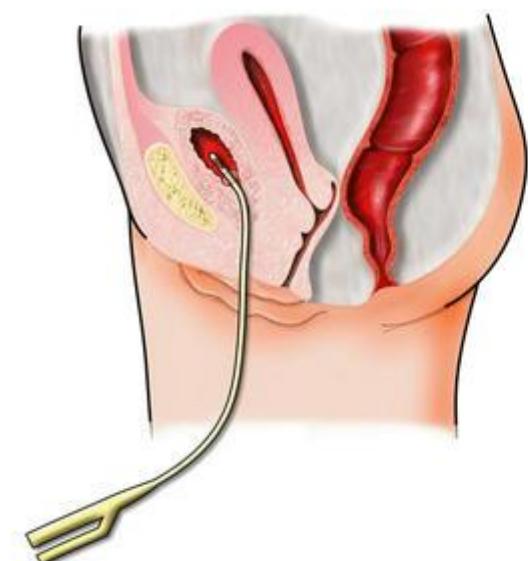
- Assessment of Renal artery stenosis
- Demonstration of VUR
- Assessment of renal transplantation
- Renal trauma

Micturating cystourethrogram (MCUG)

- Technique for visualizing a child's urethra and urinary bladder while the child urinate
- Mainly to see the VUR (Vesico Ureteral Reflux) and urethral abnormalities.

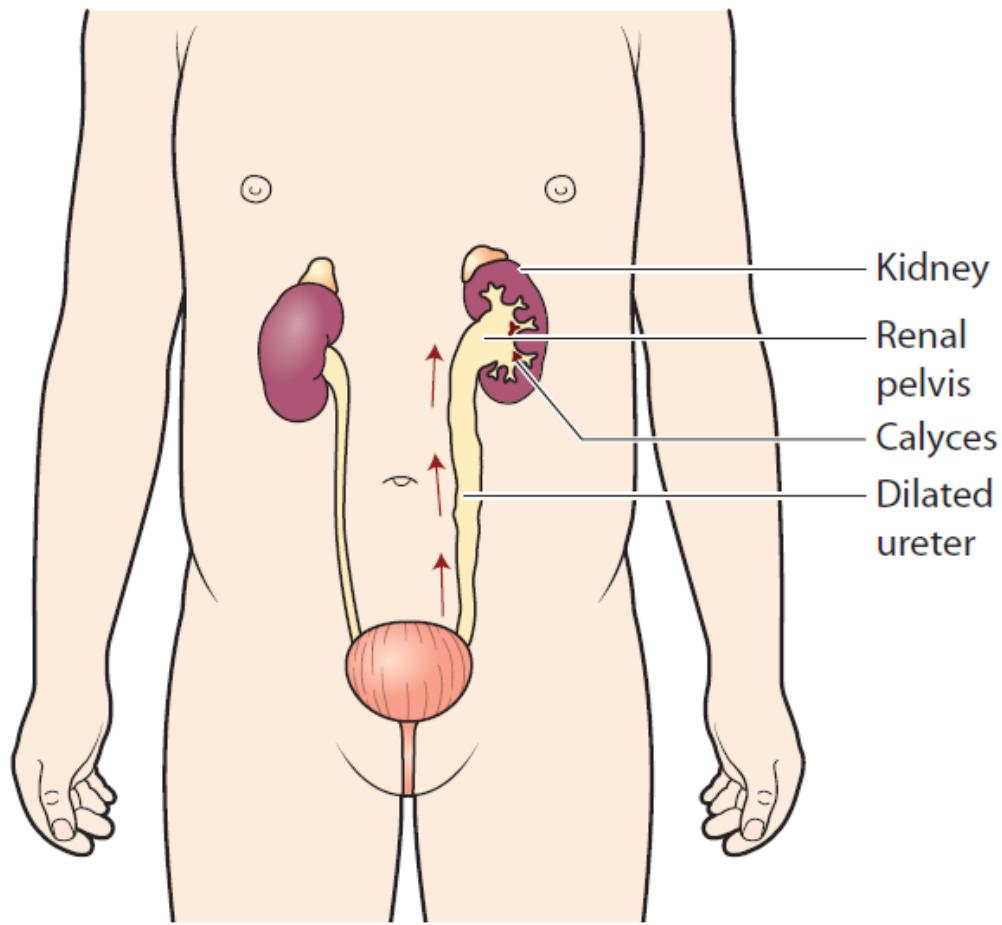


MCUG



Normal MCUG/
No Reflux

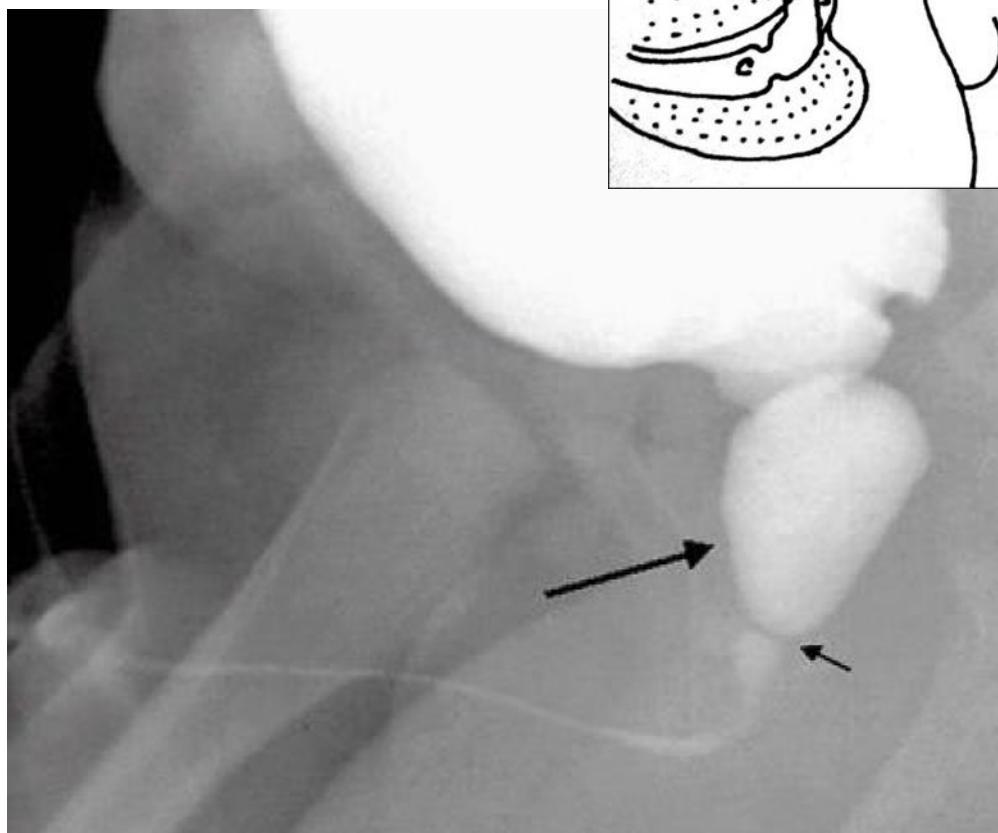
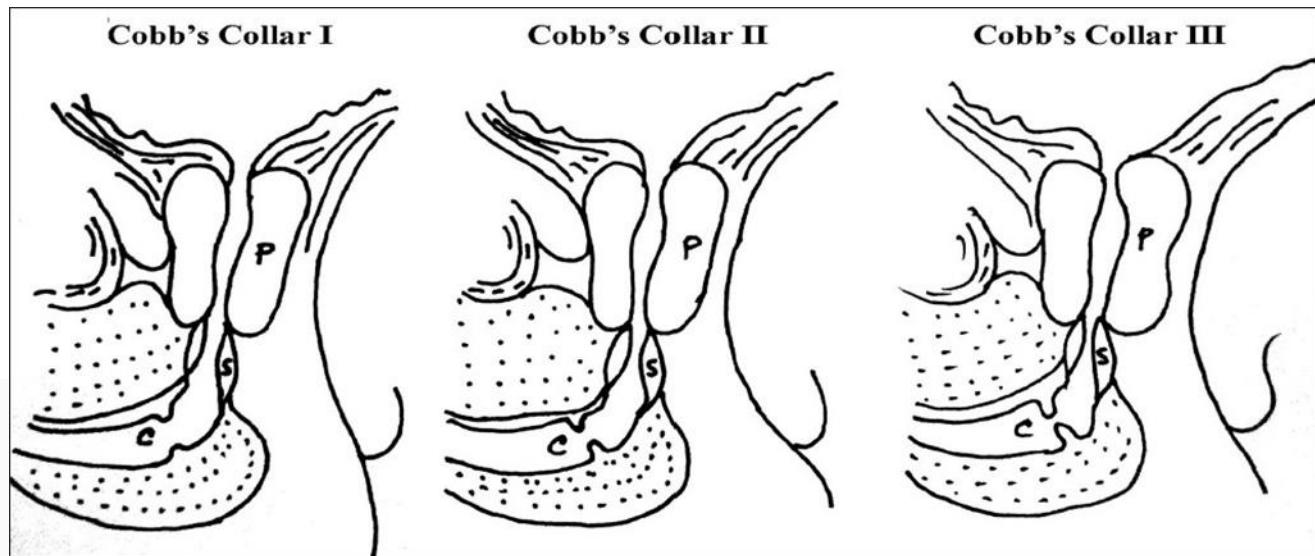
MCUG-Bilateral significant reflux



MCUG-Posterior Urethral Valve

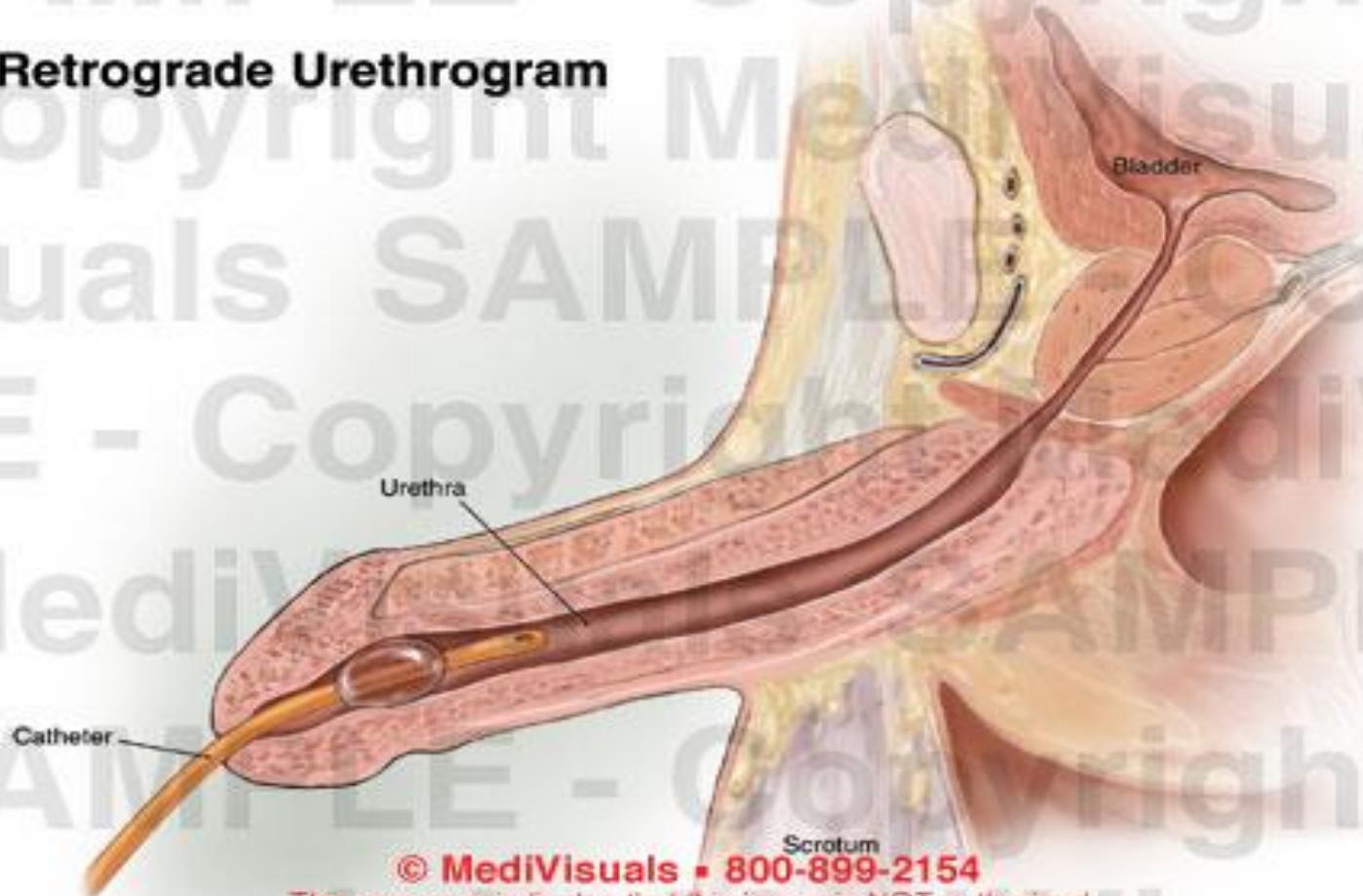
- Posterior urethral valve is an obstructing membrane in the posterior male urethra
- Result of abnormal in utero development.
- Most common cause of bladder outlet obstruction in male new-borns.
- Disorder varies in degree, with mild to severe

MCUG-Posterior Urethral Valve



Retrograde urethrogram

Retrograde Urethrogram

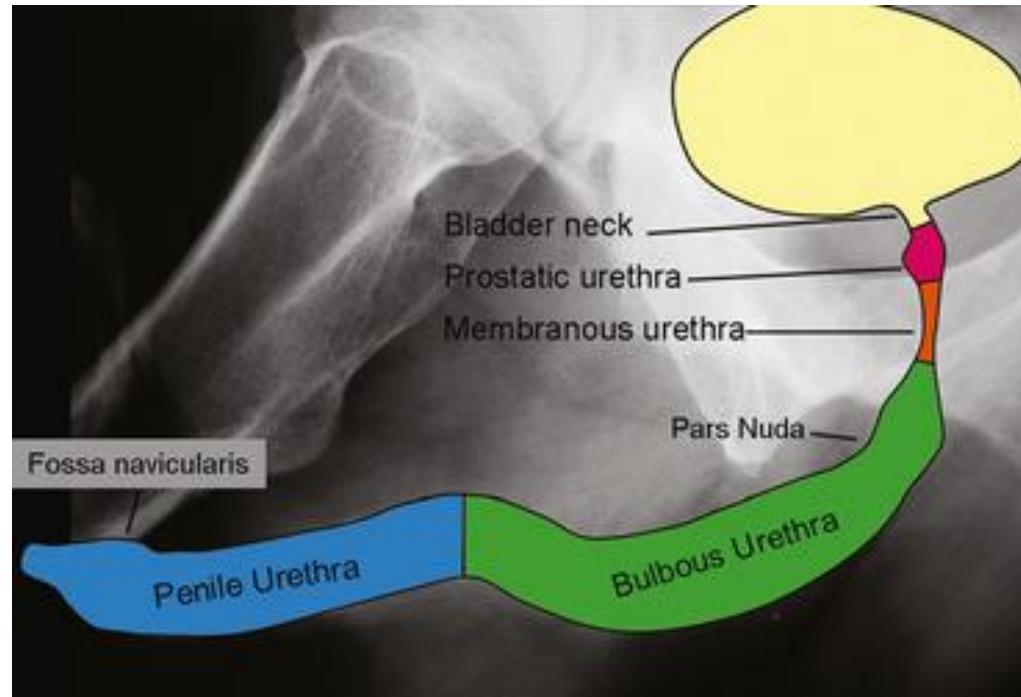
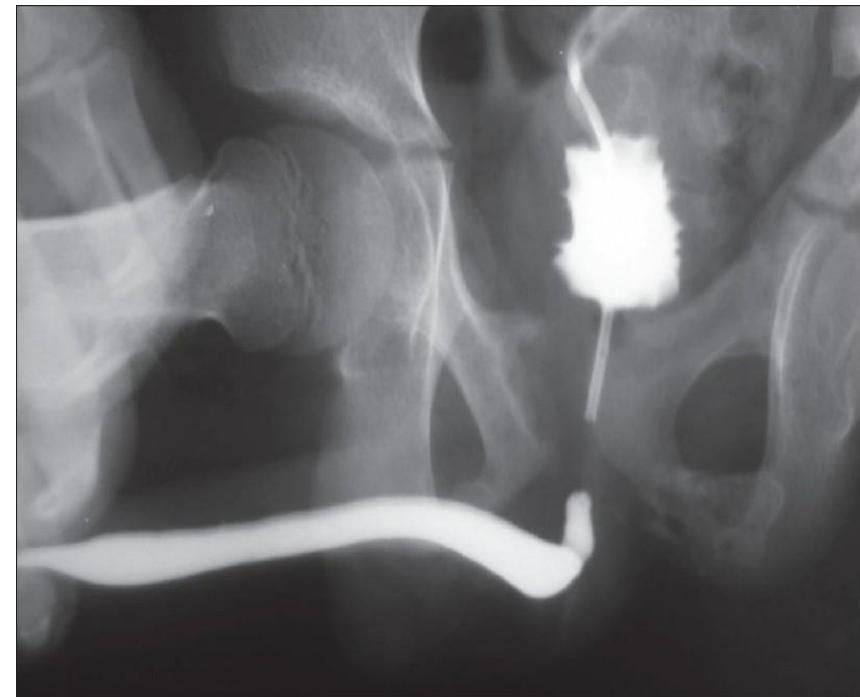


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Retrograde urethrogram



THANK YOU

