



# 430 Radiology team

## Lecture

### **Urinary Tract Radiological Investigations and Anatomy**

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#### Resources:

- Lecture by Dr. Sultan Alharbi

## Imaging modalities

- ▶ Conventional (plain) radiography (x-ray).
- ▶ Contrast studies (X-Ray + Contrast).
- ▶ US.
- ▶ CT.
- ▶ MRI.
- ▶ Nuclear medicine.

All the modalities assess anatomical structures except the nuclear scan which assesses the function.

## Conventional Radiography (X-ray)

- ▶ Often used as first imaging modality.
- ▶ Cheap.
- ▶ Useful for radio-opaque stones.
- ▶ Projectional image (one image only).
- ▶ Image contrast determined by tissue density.
- ▶ Good evaluation of radio-opaque stones.

## Contrast studies

- ▶ Can be used as first imaging modality.
- ▶ Cheap.

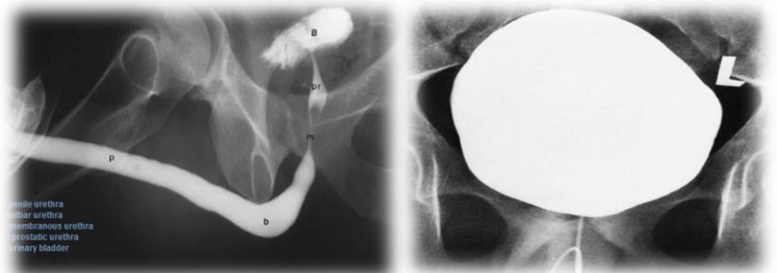
### 1) Intravenous urogram (IVU)

- Projectional image.(one image only)
- Image contrast determined by tissue density and IV contrast.
- Good evaluation of collecting system and radio-opaque stones.
- Recently replaced by CT and MRI.



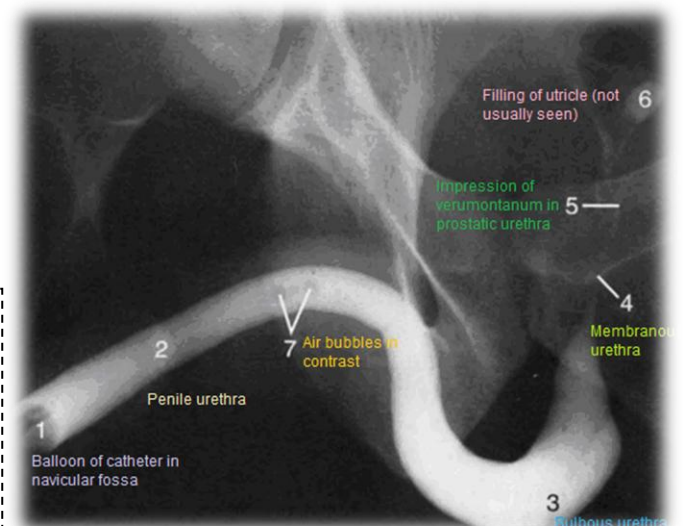
### 2) micturating cystourethrogram (MCUG)

- Use fluoroscopy (several images at different times).
- Contrast introduced to the urinary bladder by foley catheter.
- Used for vesicoureteric reflux, urinary bladder diseases(e.g. rupture-diverticulum, tumour) and posterior urethra diseases.(e.g. Posterior urethral valve).



### 3) Ascending Urethrogram

- Use fluoroscopy (continuous x-ray)
- Contrast introduced to the urethra by a small catheter.
- Used for urethral stricture, tear, congenital anomalies and fistulae. ( we can't assess posterior urethral valve with the ascending urethrogram)



Parts of the urethra: 1) prostatic, 2) membranous, 3) bulbous, 4) penile

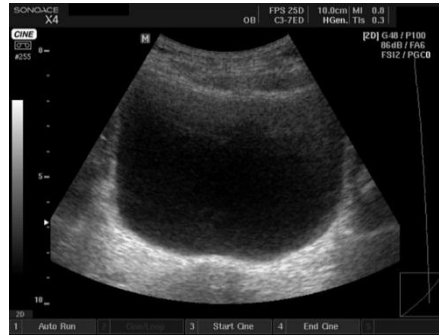
1 & 2 → posterior urethra → use MCUG.

3 & 4 → anterior urethra → use ascending urethrogram.

MCUG: fill bladder till max. capacity & check if there is retrograde movement of contrast into ureter ( to assess VUR). Then remove the foley catheter & ask patient to urinate to assess the post. urethra.

## Ultrasound

- ▶ Use high frequency sound waves.
- ▶ Contrast between tissue is determined by sound reflection.
- ▶ Operator dependent.
- ▶ Projectional image.
- ▶ Good resolution.
- ▶ Used for stone, hydronephrosis, focal lesion.



US of normal urinary bladder.  
low echogenic (black).



US of normal kidney, cortex is black  
and medulla is white (because of fat).

## CT

- ▶ Same basic principle of radiography
- ▶ Computerized tomography.
- ▶ More precise.
- ▶ costly.
- ▶ +/- contrast.
- ▶ Useful for trauma, stone, tumor, infection.
- ▶ Image features:
  - Cross sectional images.
  - Image contrast determined by tissue density +/- contrast.
  - Better evaluation of soft tissue.

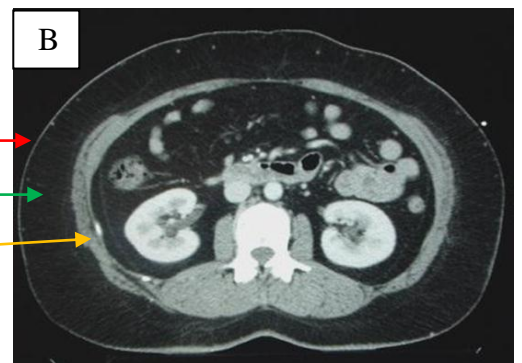
Image A: CT without contrast.

L: liver, K: kidney, S: spleen

\*: muscles.

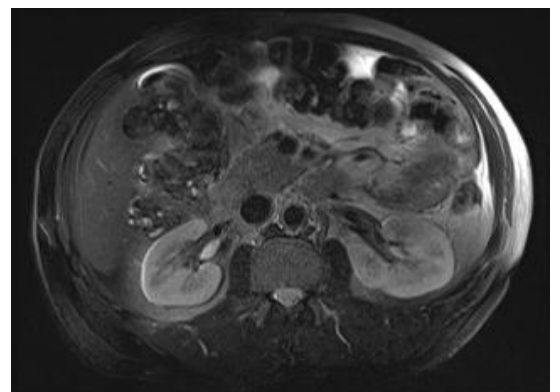
Image B: CT with contrast

CT without contrast → use for stones.  
CT with contrast → other problems.



## MRI

- ▶ Magnetic resonant imaging.
- ▶ Better evaluation of soft tissue.
- ▶ Expensive.
- ▶ Useful for soft tissue pathology (Tumor, infection)
- ▶ Image features:
  - Cross sectional images.
  - Image contrast determine by tissue properties.
  - Excellent for soft tissue evaluation.





# Nuclear medicine

- ▶ Gama camera.
- ▶ Radioactive isotopes.
- ▶ Functional test (physiology).
- ▶ Useful for evaluation of function, obstruction and scaring.

The patient here is the source of radiation. We insert the radioactive isotope that produces gamma rays & take the image by gamma camera.

## 1) Renal cortical study

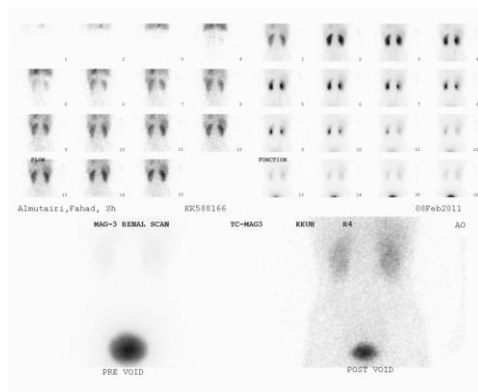
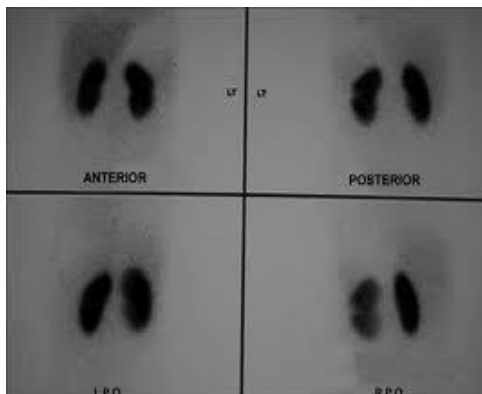
- Projectional image.
- Contrast determine by tissue uptake
- Used for split function and cortical scaring as a result of previous infections.

e.g. young male with long standing recurrent UTI, creatinine test will be normal because there is another kidney functioning well but we want to know which kidney is impaired -split function-.

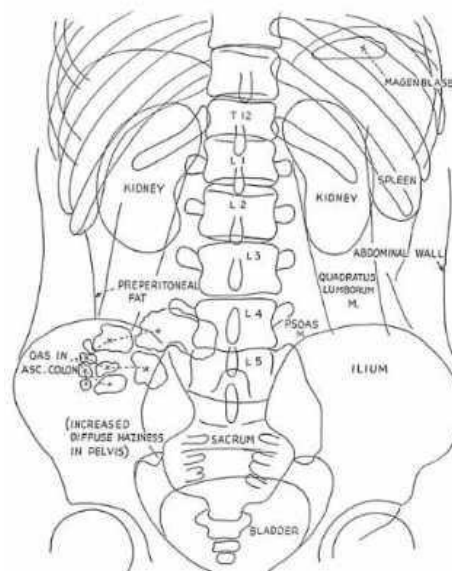
## 2) Renal dynamic study

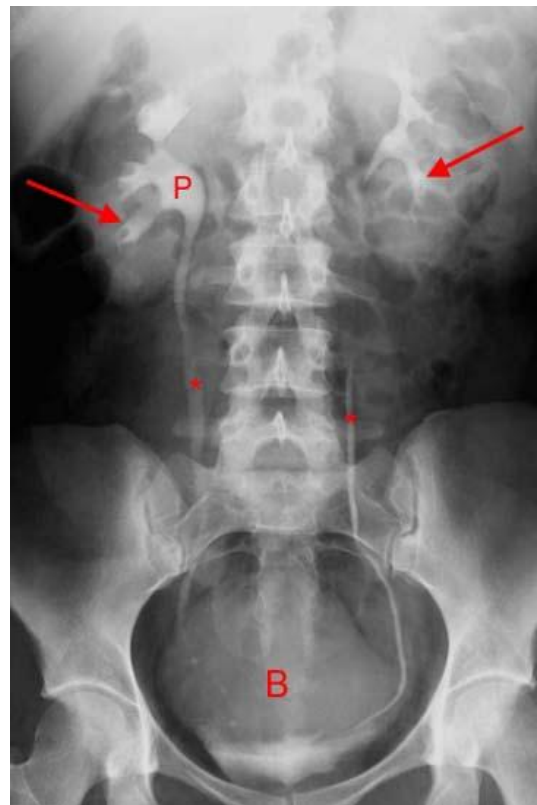
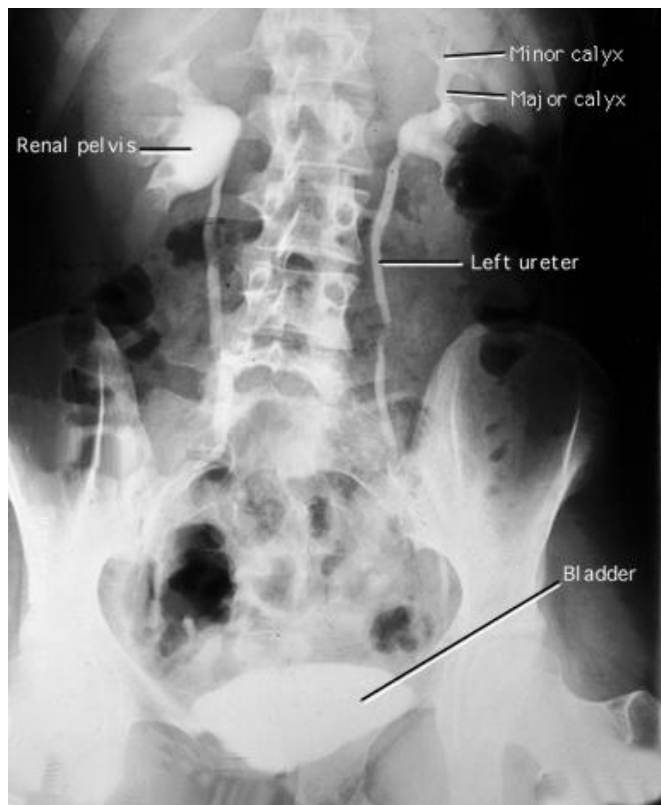
- Projectional image.
- Image contrast determine by organ blood perfusion, tissue uptake and clearance.
- used for renal perfusion, function and obstruction (e.g. obstruction of ureter).

e.g. Patient with kidney transplantation and we want to see if there is blood perfusion to the new kidney.



# Radiological Anatomy

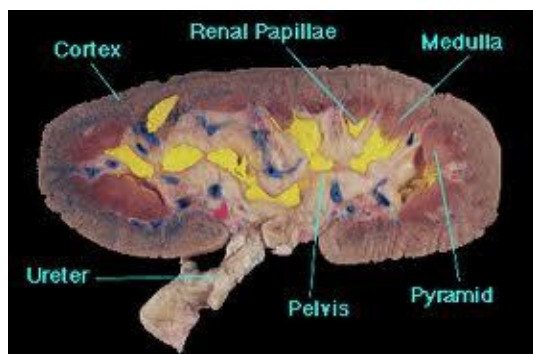




#### IVU

note: right renal pelvis is normal.

P: renal pelvis, B: bladder, Ureter(\*), calyx (red arrows).

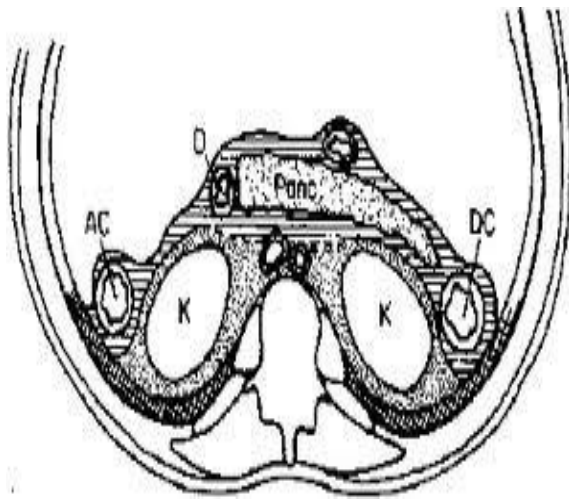


US of normal kidney.

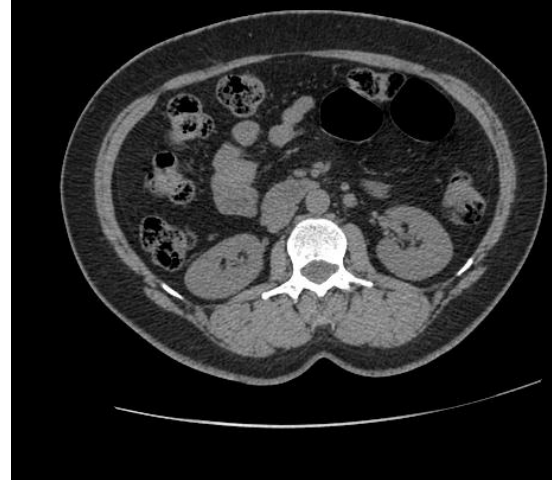
- cortex is hypoechoic (black)
- medulla is hyperechoic (white) due to the presence of fat .



#### MCUG

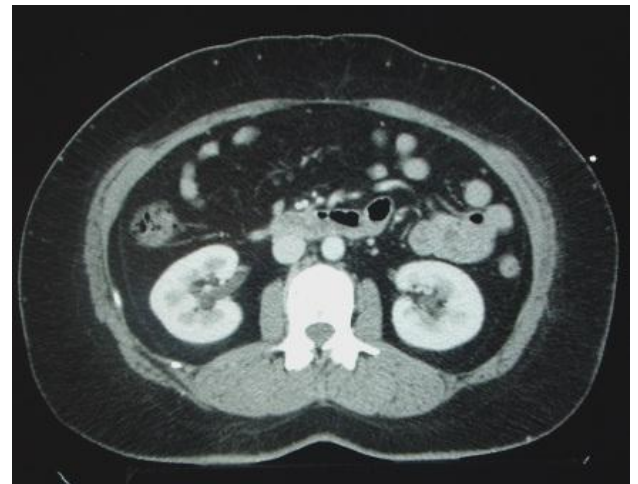
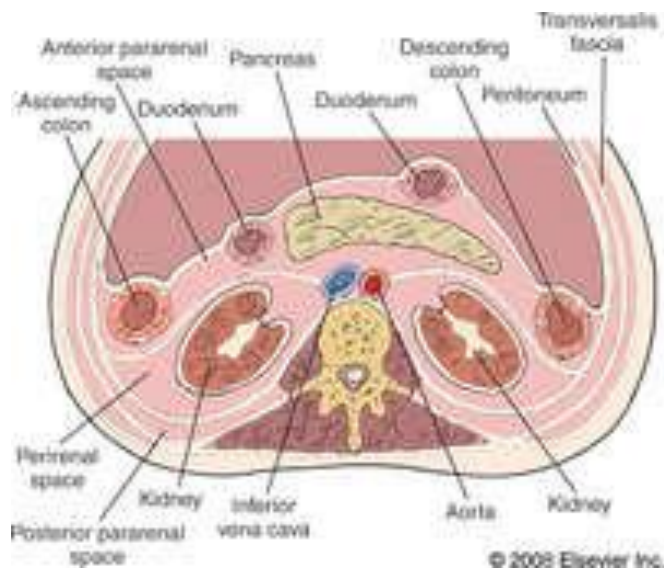


CT without contrast

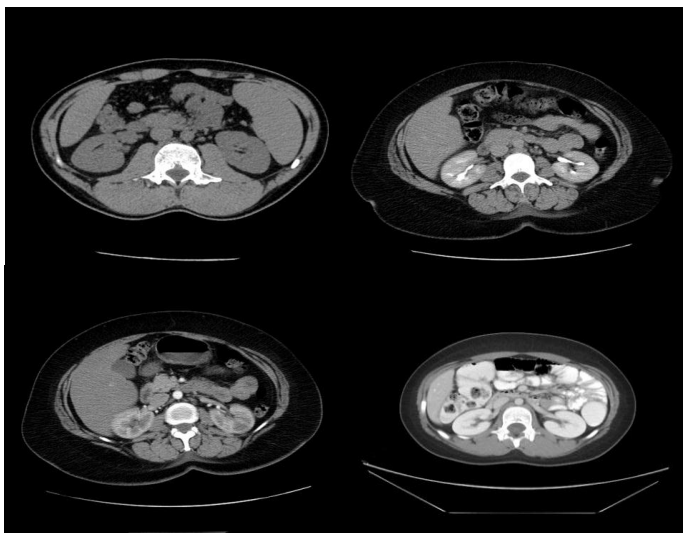


Retroperitoneal structures:

AC: ascending colon. K: kidney. D; duodenum. Panc: pancreas. DC: descending colon.



IV contrast has been given and image is taken at different times.



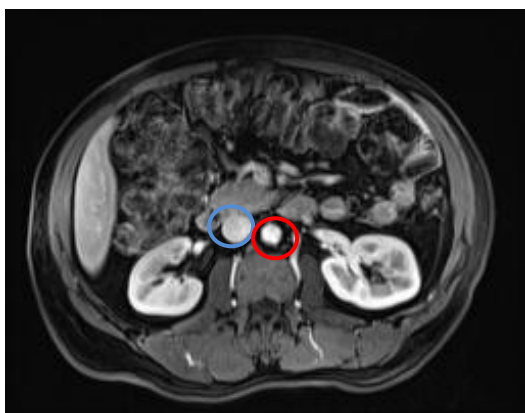




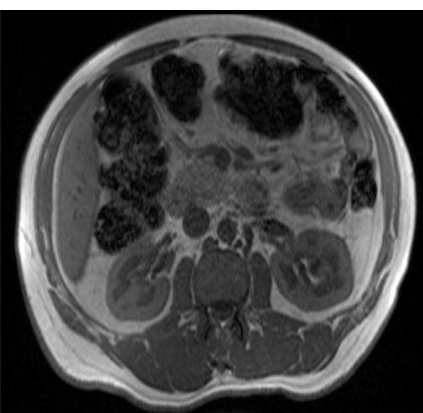
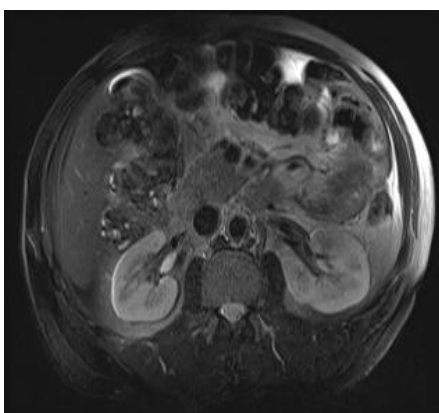
CT urography



MRI urography



MRI with contrast  
Blue: IVC, Red: aorta



MRI without contrast

# Summary

- Nuclear medicine is used for functional assessment and the other radiological modalities are used for anatomical assessment.
- In x-ray image contrast is determined by tissue density.
- X-ray has a good evaluation of radio-opaque stones.
- MCUG is used for the evaluation of the urinary bladder and the posterior urethra.
- In MCUG look for bladder rupture, VUR, filling defects in the bladder wall ( suggesting tumour), posterior urethral valve.
- Signs of posterior urethral valve: proximal dilatation, abnormal shape of bladder wall, hydronephrosis, renal impairment.
- Ascending urethrogram is used for the evaluation of the anterior urethra.
- In AU look for strictures, tearing of the urethra.
- In ultrasound high frequency sound waves are used and contrast between tissue is determined by sound reflection.
- Used for stone, hydronephrosis, focal lesion.
- CT without contrast → use for stones.
- CT with contrast → for trauma, tumor, infection.
- MRI is Useful for soft tissue pathology (Tumor, infection).
- Nuclear medicine is useful for evaluation of function, obstruction and scarring.
  - In renal cortical study contrast determine by tissue uptake and used for split function and cortical scarring as a result of previous infections. (e.g. young male with long standing recurrent UTI, creatinine test will be normal because there is another kidney functioning well but we want to know which kidney is impaired -split function-).
  - In renal dynamic study image contrast is determine by organ blood perfusion, tissue uptake and clearance (e.g. Patient with kidney transplantation and we want to see if there is blood perfusion to the new kidney).