### Imaging Techniques

1. **Ultrasonography**
   - It is high frequency sound waves.
   - During passage of these waves through human tissues they become reflected or absorbed.
   - Then received back on a screen as grades of the grey scale.
   - White → hyper echoic → paranephric fat sharply outline the kidney, medulla of renal.
   - Black → hypo echoic → clear fluid, urine.
   - Grey → iso echoic → renal cortex.

2. **Radiography**

3. **Computed tomography (CT)**

4. **Magnetic Resonance Imaging (MRI)**

5. **Radionuclide (isotopic) scan**

### Renal Ultrasonography

**Advantage**
- Cheap
- Non invasive
- Easy
- Safe
- No special preparation
- No contrast injection

**Disadvantage**
- Operator dependant
- Tissue non specific
- Limited in obesity, bowel gases, evaluation of the ureter.

**Information from renal ultrasound**
- Kidney site
- Kidney size
- Cortical thickening
- Corti-comedullary differentiation

**Detection of (osce)**
- Stones → hyper echoic, posterior acoustic shadow
- Renal cyst → regular, rounded, smooth outline, no internal echoes
- Tumor → solid mass, in the cortex
- Peri-nephric collections → Urinoma, Hematoma, Abscess
- Back pressure changes → dilatation of pelvis and calyces, thinning of the parenchyma

### Bladder U/S

1. Detection of bladder stones
2. Detection of bladder tumor
3. Diagnosis of BPH (Large prostate)
4. Estimation of residual urine after voiding

**X-ray characteristics**
- X-ray is an electromagnetic wave characterized by ability of:
  - Materials absorb x-rays → white (bone).
  - Solid organs → in between penetration
  - Materials allow penetration → black (air).

**Criteria of good KUB (osce item)**
1. Centralized
2. Can see last 2 ribs + lower border of symphysis pubis
3. Can see transverse process
4. No excessive gas

**Comment on KUB (osce item)**
1. Bone
2. Soft tissue shadow
   a) Renal outlines
   b) Psoas shadow
   c) Organomegally
      (Liver/Spleen)
3. Radio-opaque shadow
4. Gas

### KUB

**Bony abnormalities**
- Osteoblastic lesions in → Metastatic prostate cancer
- Osteolytic lesions in → Metastatic renal cell carcinoma
- Spine abnormalities may be associated with → Neuropathic bladder
- Fracture pelvis, ribs

**Radio opaque shadow**
- Renal stone (80-90% of renal stones are opaque)
- Gall bladder stone
- Calciﬁed lymph node

**Causes of radio-opaque shadow in the hypochondrium**
1. Renal stone
2. Gall bladder stone
3. Calciﬁed lymph node

**Causes of radio-opaque shadow in the course of the ureter**
1. Ureteral stone
2. Phlebolith
3. Calciﬁed lymphnodes

**Gas shadows**
- Colonic gases
- Gas inside the urinary system:
  a) Iatrogenic → (After nephrostomy)
  b) Emphysematous Pyelonephritis

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*Urological radiology*
### Intravenous Urography (IVU)

#### Introduction
- Intravenous injection of iodine-containing contrast medium (White color with X-Ray).
- The kidneys will concentrate the contrast from the blood and excrete it with urine.
- Serial X-Ray pictures will show the pelvi-calyceal system, the ureter and bladder.

#### Indication
1. Hematuria
2. Urolithiasis
3. Hydronephrosis

#### Contraindications
1. Hypersensitivity to iodinated contrast
2. High serum creatinine (>1.6 mg/dl)
3. Severe hypertension, Heart failure
4. Pregnancy

#### Normal IVU
- Normal pelvis is funneled and divided to 3 major calyces and each major → minor calyces

![Normal IVU Image](image)

#### Normal Ureteral course
1. The ureter appears as white band on the transverse process of lumbar vertebrae.
2. Then passes over the sacroiliac joint.
3. Then turns medially to the bladder

#### Bladder shape
1. Round
2. Regular
3. Not opacified

![Bladder shape Image](image)

#### Renal cyst
- In IVU
  - Causes of no contrast excretion by one kidney
    1. Congenitally absent kidney
    2. Surgically removed
    3. Non-functioning kidney
    4. Attack of renal colic

#### Osce
- Minor side effects
  - Most common
  - Resolve in few minutes without treatment
  - Manifestations
    1. metallic taste
    2. Tachycardia
    3. Flushing
    4. Nausea

- Nephro-toxicity
  - Acute renal impairment after contrast injection
  - Usually reversible within 3-5 days
  - Risk factors for nephro-toxicity:
    1. Renal impairment (creatinine >1.6 mg/dl)
    2. Diabetes because of diabetic nephropathy
    3. Dehydration
  - Precaution to avoid nephro-toxicity
    - Good hydration
    - Use of non-ionic low osmolar contrast medium

- Anaphylactic reactions
  - Rare but dangerous
  - Manifestations: one or more of
    1. Generalized urticaria
    2. Facial, Laryngeal, pulmonary edema
    3. Broncho-spasm
    4. Hypotension, shock
    5. Cardiac arrhythmia
  - Require treatment → corticosteroids
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Antegrade Pyelography</th>
<th>Retrograde Pyelography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyelography</td>
<td>Antegrade: through a nephrostomy → it shows the shape of the pelvis and calyces, ureter</td>
<td>Retrograde: through a ureteric catheter</td>
</tr>
<tr>
<td></td>
<td>Must be performed under sterile condition</td>
<td>Contraindicated in infected system</td>
</tr>
<tr>
<td>Cystography</td>
<td>Direct injection of the contrast to the bladder through a catheter</td>
<td></td>
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<tr>
<td></td>
<td>It shows:</td>
<td></td>
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<td></td>
<td>a) Bladder shape</td>
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<tr>
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<td>b) Bladder capacity</td>
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<td>c) Vesico-ureteral reflux</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Post-void residual urine</td>
<td></td>
</tr>
<tr>
<td>Voiding Cystourethrography</td>
<td>Imaging during the act of micturation → Evaluate the bladder and urethra</td>
<td>Better in visualization of posterior urethra in males (PUV) and whole urethra in female</td>
</tr>
<tr>
<td>Renal Angiography</td>
<td>Direct injection of the contrast through the renal artery</td>
<td>Abnormal vascularity of malignant renal tumor</td>
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</table>
### Computed Tomography
- The patient is exposed to multiple X-ray beams.
- During passage of the beam in human tissue, it is absorbed (attenuated) in different quantities depending on the tissue.
- Then, the amount of residual radiation is measured by special detectors.
- The findings are described as:
  - **Hyperdense:** White
  - **Hypodense:** Black
  - **Isodense:** Grey

<table>
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<th>Advantages</th>
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<tr>
<td>1. Good resolution</td>
<td>1. Radiation exposure</td>
</tr>
<tr>
<td>2. Operator independent</td>
<td>2. May need contrast medium injection</td>
</tr>
<tr>
<td>3. Not affected by bone or gas</td>
<td>3. Expensive</td>
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<td>4. Can detect small lesion</td>
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<td>5. Non-invasive</td>
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#### Indications of CT
1. Diagnosis of the cause of renal colic
2. Staging of urological tumors → Kidney, ureter, bladder
3. Follow-up after treatment of:
   a) Urological tumors
   b) Urolithiasis

#### Helical (Spiral) CT
- Spiral movement of the x-ray source
- Movement of the patient through it
- High sensitivity in detection of stones specially when performed without contrast administrated (NCCT).

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<td>3. Not suitable for patients with metallic implants</td>
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| 4. Excellent soft tissue characterization | |}

### Magnetic Resonance Image (MRI)
- Images obtained by placing the patient in a strong magnetic field.
- The hydrogen atoms of the body will be arranged within the field in a special manner.
- They will oscillate when the magnetic field stimulate them at a specific frequency.

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### Radionuclide (Isotopic) Scans
- Renogram is done by injection of a radio-active material coupled with chemical substance that is concentrated by the kidney
- Then measuring the radio-activity at the renal areas using gamma camera

#### Indications:
1. Assessment of renal functions.
2. Diagnosis of obstructive uropathy

### Simple renal cyst by US
### Renal stone by US
### Renal tumor by US
### Back pressure changes in US