



431

## Radiology Team

◆ Leader: Lama AlShwairikh

◆ Sub-leader: Abdulaziz Almutair

## Lecture 9: Radiology of Urinary System Disease



Done By: Sama Al Ohali

Revised By: Lama AlShwairikh

◆ Important

◆ Doctor's notes

◆ Team's notes

## Urinary System Diseases:

- 1- Renal Colic. **There are two kinds of stones:** radiopaque and radiolucent.
- 2- Urosepsis.
- 3- Renal Mass.
- 4- Acute/Chronic Renal Failure.
- 5- Trauma.

### 1) Renal Colic

\*Renal colic is an acute syndrome involving unilateral flank pain, linked to an obstruction in the upper urinary tract.

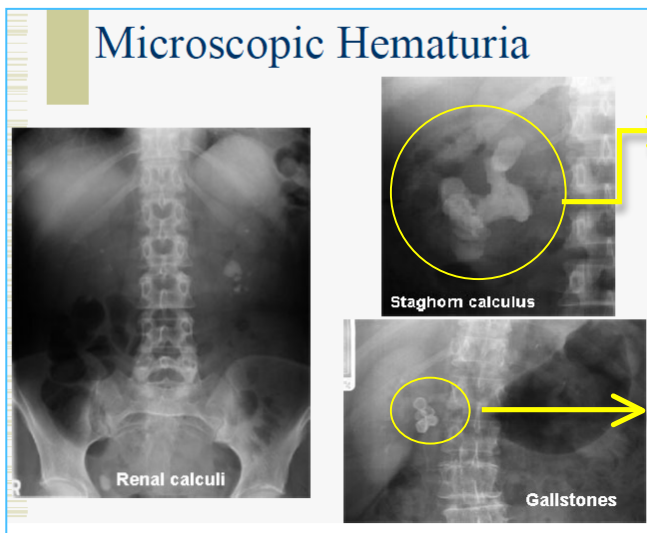
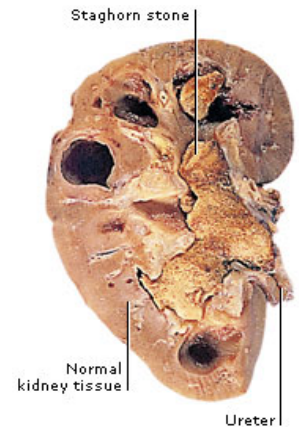
If a patient presents with renal colic, the doctor should answer the following Questions:

- \*Are urinary stones present? If so, what is the level, size, and location?
- \*Is obstruction present? If so, what is the level, severity, and is partial or complete obstruction?
- \*Is urgent intervention required? Factors include: urosepsis, solitary kidney, severe pain. **By intervention, we mean** treating the patient with percutaneous nephrostomy or ureteric stent.



#### A) Radiopaque Stones:

Multiple opaque shadows are seen in the left side of the abdomen, and this area is projecting over the left kidney. This means, that it is most likely a renal stone.



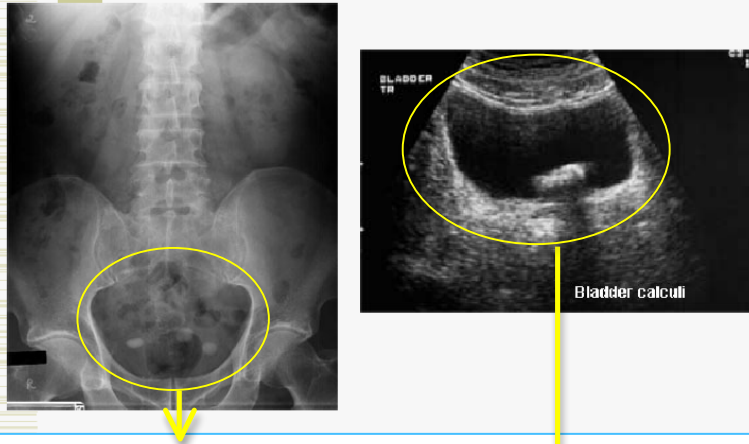
We can see a large opaque shadow taking the shape of the pelvicalyceal system. (staghorn stone)

Multiple opaque shadows are seen close to the hilum of the right kidney. These are **gallbladder stones**. Gallbladder stones can mimic renal stones.

#### How to differentiate between a gallbladder stone and a renal stone?

- A **gallbladder stone**: is multiple but uniform in size + Hypodense in the center + Hyperdense (bright) in the periphery.
- A **renal stone**: is not rounded, not uniform even if they are multiple + they don't have the hypodensity in the center.

## Microscopic Hematuria Bladder Calculi

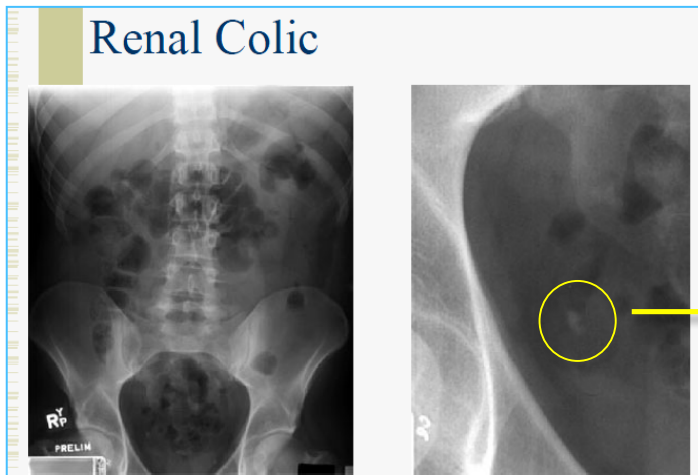


Radiopaque shadow in the pelvis.

- **Note:** It is better NOT to specify the exact location of the shadow in a plain film because we really don't know where it is exactly.
- So say a shadow in the pelvis NOT in the bladder NOT in the ureter
- After you do Ultrasound, CT, IVP...etc. Then you can say the stone is where exactly, whether it is in the distal ureter or in the bladder.

- A whole sac filled with fluid. This is the bladder. Fluid is dark in the US and stones are bright. The acoustic shadowing\*, which is the dark shadow, tells us this is a stone.
- An acoustic shadow is an area through which sound waves fail to propagate, due to obstructions or disruption of the waves. It's dark and seen behind the stone.

## Renal Colic



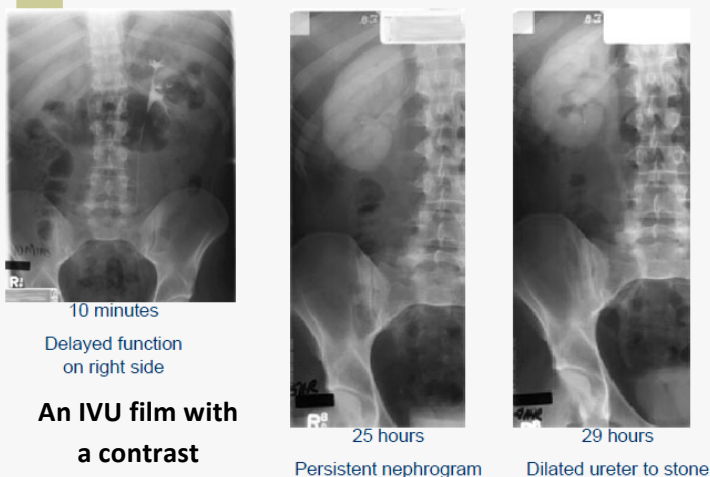
Tiny shadow in the right pelvis.

A magnified focus spot film showing a Tiny shadow in the right pelvis.

IVP preliminary film (control film) in a patient with right renal colic.

A preliminary radiographic: Imaging made before the administration of contrast material. Also called scout image.

## Renal Colic

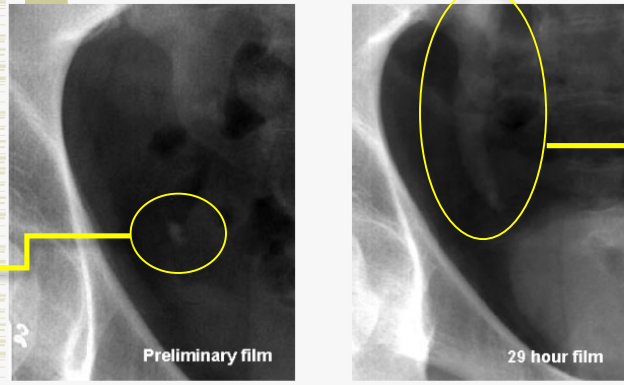


An IVP film with a contrast

- You can see the left pelvicalyceal system and part of ureter is filled with the contrast, which means the left kidney is functioning well and excreting the contrast in the 10 minute film. Also, there is no dilatation in the pelvicalyceal system, nor in the ureter.
- Whereas in the right side of 10 minute film shows no contrast, which means it is not functioning well. Why? Because of the obstruction in the distal ureter. "seen in the previous preliminary film"
- The right ureter is very dilated compared to the left ureter.
- The normal diameter of ureter is 3 mm.

## Renal Colic

The stone in distal ureter. most likely at the vesicoureteral junction (ureterovesical Junction), on of the three narrowest areas of the ureter.



Radiopaque stone distal ureter

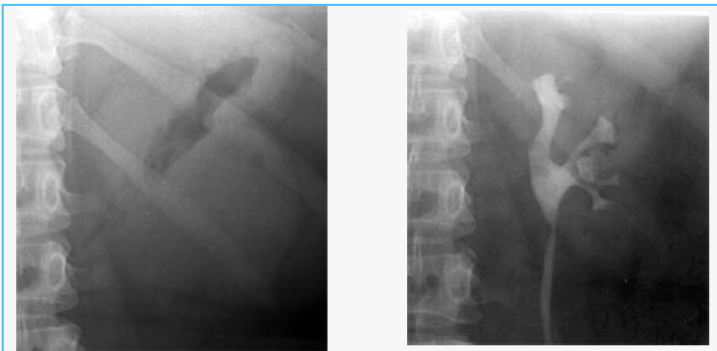
The dilated ureter.

The three areas of normal narrowing:

- 1) Ureteropelvic junction.
- 2) Bifurcation of the iliac vessels.
- 3) Ureterovesical junction.

## B) Radiolucent Stones:

Radiolucent stones CAN'T be seen by x-ray. However, they can be seen by Ultrasound and CT.

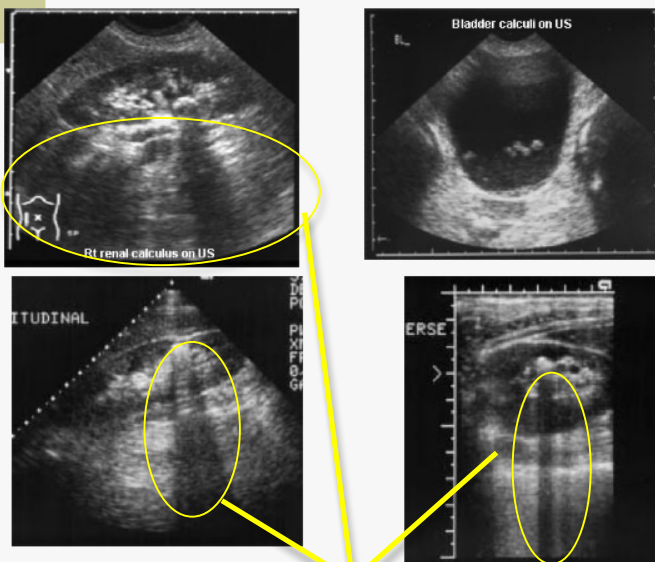


Radiolucent uric acid stones

KUB imaging. (Kidney, Ureters and Bladder)

A filling defect can be seen (not filled by the contrast), which indicates obstruction. Could be a mass, a stone...etc.

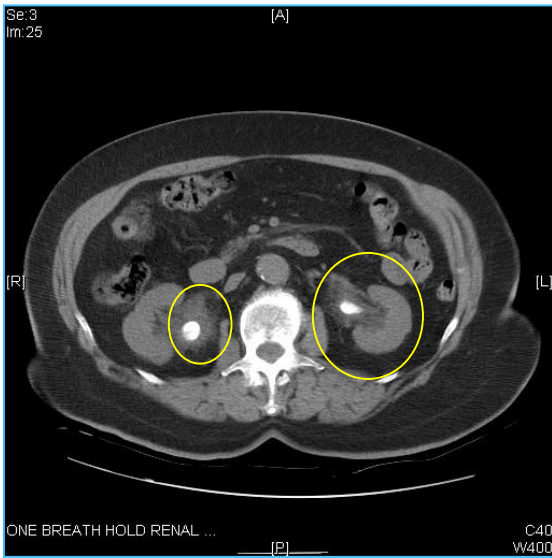
## Renal Calculus - US



Acoustic shadowing.

- **Top left:** you can see the cortex, medulla, hyper echoic shadow, and acoustic shadowing, indicating a stone.
- **Top right:** bladder filled with urine "fluid is always black in US". Hyper echoic shadow floating, indicating stones.
- Acoustic shadowing is NOT always seen maybe because of technical problems. Another possibility, the urine is dark and the shadow is also dark, they can be overlapping.





Stones at uretero-**pelvic** junction. Fluid is surrounding the stones. They are causing obstruction.



You can see small dots in the right kidney, which are small stones. CT scan is very sensitive, it can detect stones less than 1 mm.



A stone in the left kidney. It is located in the **calyx**.

#### Note:

- ❖ Peripheral stone: in Calyx → not causing obstruction
- ❖ Central stone: in Pelvic area → cause obstruction.
- ❖ Stones must be removed if they are either causing severe pain or obstruction.
- ❖ Although CT is the most sensitive test for detecting stones, we don't always start with it because of the ionizing radiation.

## Hydronephrosis



- You can see dilated pelvis of the right kidney, indicating hydronephrosis.
- Urine is seen as well, meaning obstruction, which could be due to stones or other causes.

\*Hydronephrosis — literally "water inside the kidney" — refers to distension and dilation of the renal pelvis and calyces, usually caused by obstruction of the free flow of urine from the kidney. Untreated, it leads to progressive atrophy of the kidney. In cases of hydroureteronephrosis, there is distention of both the ureter and the renal pelvis and calyces.

## Management of renal stones:

Depends on location, and size of the stone. It can be managed by Extracorporeal Shock Wave Lithotripsy (ESWL), ureteroscopy, percutaneous debulking and then ESWL. Surgery is rarely done.

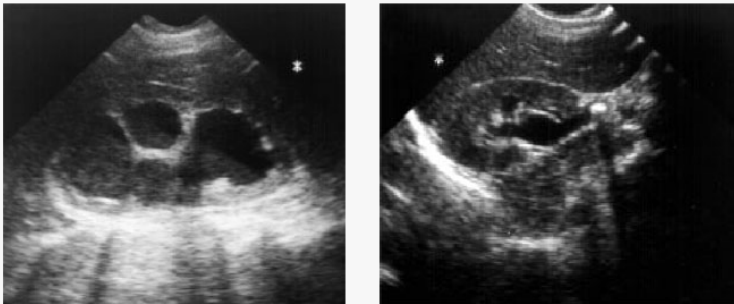
\*Extracorporeal shock wave lithotripsy (ESWL) uses shock waves to break a kidney stone into small pieces that can more easily travel through the urinary tract and pass from the body.



## 2) Urosepsis

- Urosepsis is a secondary infection that occurs when a urinary tract infection spreads to the bloodstream.
- Its is clinically diagnosed generally.
- The primary infection can be: Pyelonephritis, Cystitis, and prostatitis.
- **Urosepsis and an obstructed ureter is a Urologic Emergency. Why?** Because the patient can go into a septic shock.
- If the doctor suspect a urosepsis, a renal US should be performed to rule out renal obstruction, and renal or perirenal abscess.

### Urosepsis

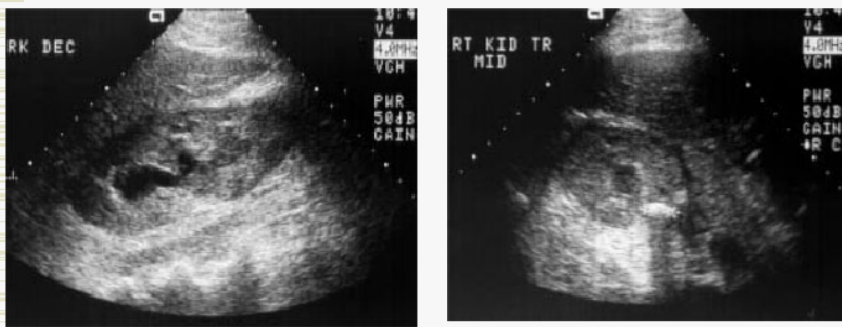


Left pyonephrosis      Right UPJ stone causing hydronephrosis

Left US image:

- The kidney is showing pyonephrosis, the cortex is **thin**, and we can't see the medulla.
- The calyx is **dilated**.
- The fluid is **infected (pus)** "NOT clear fluid "NOT totally black". If it's completely black, the urine could be clear, or there's not much pus.
- Could be complicated by abscess in the kidney.
- Normal diameter of the cortex: 2.5 cms. (It's not fixed, for example 1.2 cms is not considered normal, 0.8 is considered thin.
- The cortex is thin because of obstruction, hydronephrosis and loss of renal tissue.

### Urosepsis



Ultrasound showing a right pyonephrosis and obstructing UPJ stone

## Urosepsis



Percutaneous nephrostomy for decompression



2 weeks post ESWL

We said urosepsis is an emergency. So what to do in such cases?

We insert a tube (catheter) through the skin to the calyx to renal pelvis. This is called nephrostomy tube. This is done to relieve the pressure over the kidney. Later on you can go for ESWL.

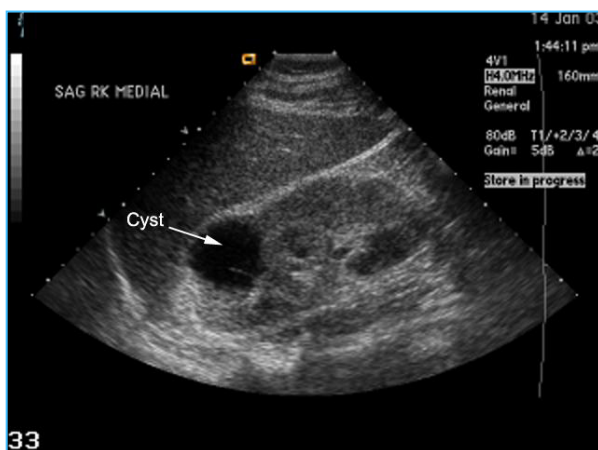
## 3) Renal Mass

- A mass can be solid, simple cystic or atypical (complicated) cystic.
- The US is one of the most sensitive modality for differentiating a solid form a cystic mass. **US is better than CT to tell if the is a solid or a cystic mass.**

Simple cysts are usually present in many people after the age of 50.

### Approach to renal masses:

- Most renal masses are simple cysts.
- Use US to characterize the mass:
- If you find a simple cyst, then STOP. "Nothing further to do"
- If you find either a solid mass or atypical cyst, then you should do CT. CT should be with IV contrast or it will not help us.



An US showing a large simple cyst.

## Renal Mass



Left renal mass on IVP

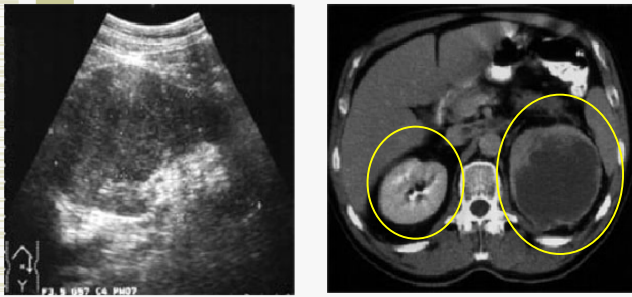


Simple cyst on ultrasound

IVP showing a stretching of the upper pole, indicating a cystic lesion, which was confirmed by US.

**Simple kidney cysts:** abnormal, fluid-filled sacs that form in the kidneys. They are usually unilateral and solitary lesions with well-defined features. They do not enlarge the kidneys, replace their normal structure, or cause reduced kidney function.

## Renal Mass



### Solid left renal mass in a patient with micro hematuria

Left CT image: you can see the difference between the two kidneys. The size, appearance and enhancement. There is a mass in the left kidney.

#### ❖ A renal mass can be malignant or benign

- 90% of all renal malignancies are due to **renal adenocarcinoma**.
- 15-13% are metastatic at diagnosis.
- Hematogenous and lymphatic spread.
- 10% have venous invasion. (Renal vein or IVC)
- **Treatment:** Radical or partial nephrectomy.

#### ❖ **Appropriate imaging workup:**

- **Chest x-ray:** Pulmonary metastases.
- **CT abdomen:** Local invasion, lymphadenopathy, and venous extension.
- **MRI abdomen:** if there is contraindication to IV contrast. "Renal failure or contrast allergy"

#### ❖ **Renal Angiomyolipoma:**

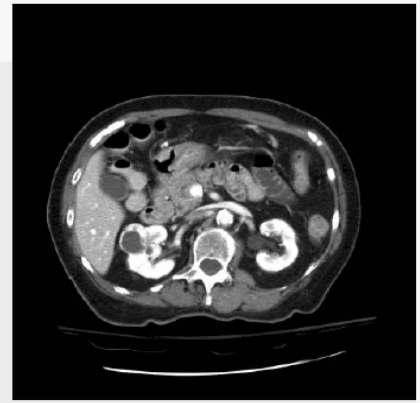
- A benign hamartomatous tumour comprised of **vessels**, **smooth muscle**, and **fat**.
- Usually asymptomatic.
- Occasionally present with hemorrhage when large or multiple.
- Fat detected in 96% by CT.

#### ❖ **Transitional cell carcinoma (TCC):**

- Most common malignancy of **pelvicalyceal system**, ureter and bladder. "Not kidneys"
- <10% of renal malignancies.
- Typically present with gross hematuria.
- CT for staging and surgical planning.
- **Treatment:** Radical nephrectomy.

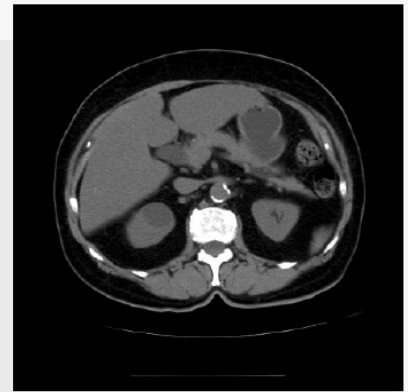
## Renal Carcinoma

- if US indicates that the mass is solid, CT with IV contrast can characterize the tumour in greater detail – delineate extent, show the degree of vascularity, presence/absence of necrotic centre, presence/absence of local invasion of adjacent structures



## Renal Cysts

- US will determine if the lesion is cystic or solid
- 2 Types of Renal Cysts:
  - 1) Simple: spherical, echo-free fluid collection within a thin surrounding wall and will show good sound wave transmission
  - 2) Complicated: will show the presence of echos within the cyst, will have a thick wall, and/or show calcification in the wall



## Renal Mass

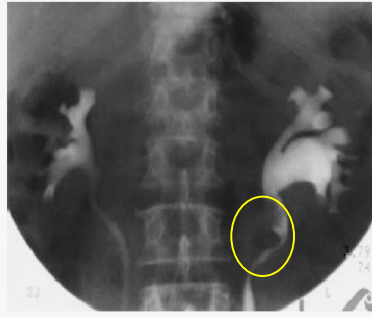


Distortion of left pelvicalyceal system in IVP

This indicates a problem. You have to do US or CT.



## Transitional Cell Carcinoma



A filling defect could be due to a:

- Tumor
- Clot
- Stone

Proximal left ureter shows irregularity with a filling defect.

IVP and retrograde pyelogram TCC proximal left ureter

## Transitional Cell Carcinoma



Dilation of the pelvicalyceal due to the distal obstruction.



Compare the normal wall of the bladder on the right to the thickened irregular wall in the left.

IVP and pelvic CT – large TCC of bladder obstructing right ureter

You can see a large filling defect in the bladder. In CT you can see a fluid-fluid level, contrast and urine are not mixed together. There's a mass in the right side of the bladder.

## Transitional Cell Carcinoma



Bladder TCC in two patients

## Transitional Cell Carcinoma



Small TCC of bladder in patient with hematuria

Filling defect in the left side of the bladder.

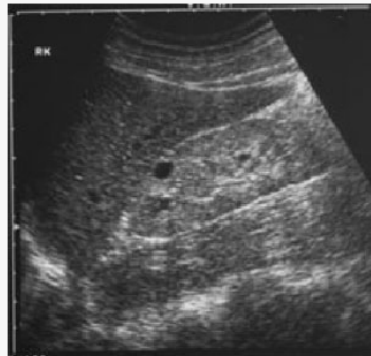
## 4) Acute and chronic Renal Failure:

- ◆ Clinical categories
  - Prerenal (dehydration, shock, cardiac failure)
  - Renal (parenchyma, diabetes, GN, drugs, renovascular)
  - Postrenal (obstruction)
- ◆ IV contrast **contraindicated** if creatinine > 200 mmol/d
- ◆ Use ultrasound to assess:
  - Renal size
  - Parenchymal thickness
- ◆ Ultrasound guided renal biopsy to establish diagnosis

## Acute and Chronic Renal Failure



Hydronephrosis post-renal



Atrophic, echogenic kidney  
Medical renal disease

**Acute:** The kidney is enlarged in size. It is edematous. Sometimes there is obstruction.

**Chronic:**

- Small in size.
- Bright echo pattern.
- The normal darkness of the cortex is NOT seen.
- We CAN'T differentiate between cortex and medulla, because they have the same echo pattern.
- Some cysts can also be seen.

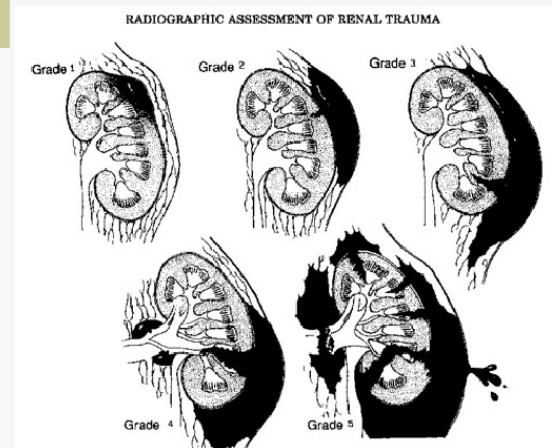
## 5) GU Trauma

- Penetrating trauma. (Gunshot, stab)
- If patient is Unstable → go for surgery or angiogram “to stop bleeding (Therapeutic effect)”
- If stable → you can go for CT, and other modalities

**Renal trauma grading:** Often done using the American Association for the Surgery of Trauma (AAST) according to depth of damage and involvement of the urinary collecting system and renal vessels.

<http://radiopaedia.org/articles/renal-trauma-grading>

## GU Trauma



## GU Trauma

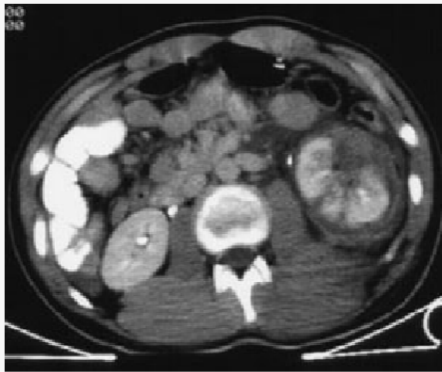


Grade 5 injury: thrombosed renal artery

The CT scan and angiogram of traumatic patient:

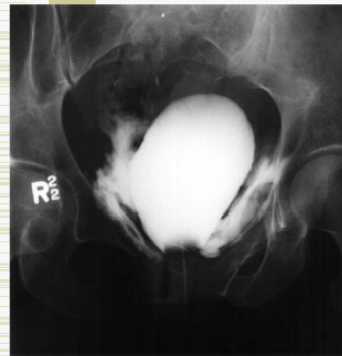
- Low visualization of right kidney.
- Only part of the renal artery can be seen.
- You can also see that the kidney is not perfused at all.
- No blood supply due to thrombosis of renal artery.

## GU Trauma



Grade 4 injury: deep lacerations with perirenal hemorrhage

## GU Trauma



Extraperitoneal bladder rupture

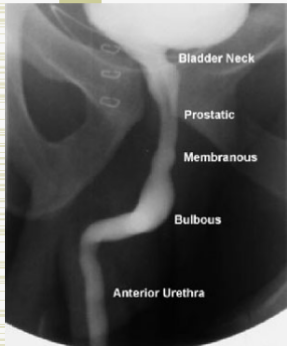


Intraperitoneal bladder rupture

For a urinary bladder injury: do a cystogram.

- Extra peritoneal leak → the contrast doesn't extend to the abdomen.
- Intraperitoneal leak → the contrast extends to the abdomen.

## GU Trauma



Normal retrograde urethrogram



Traumatic rupture of bulbous urethra

- For urethral injury: perform voiding cysto-urethro-gram "inject contrast and let patient urinate while scanning".
- You can see irregularity and leak in bulbous urethra, which is due to trauma.

**Good Luck!**

