



Radiology Team

Lecture 8 Radiology of urinary system diseases

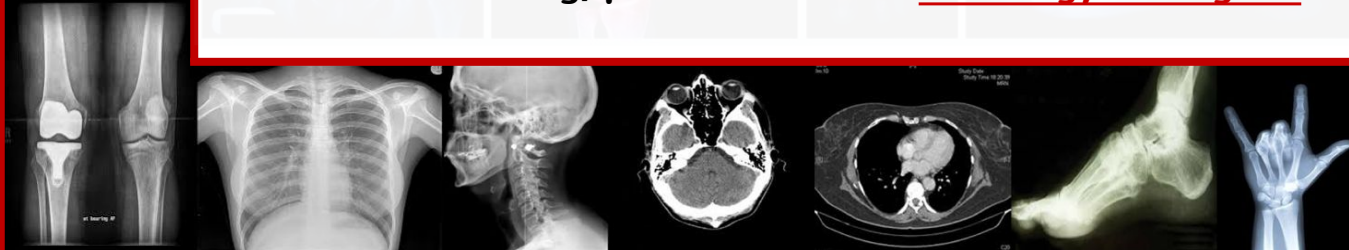
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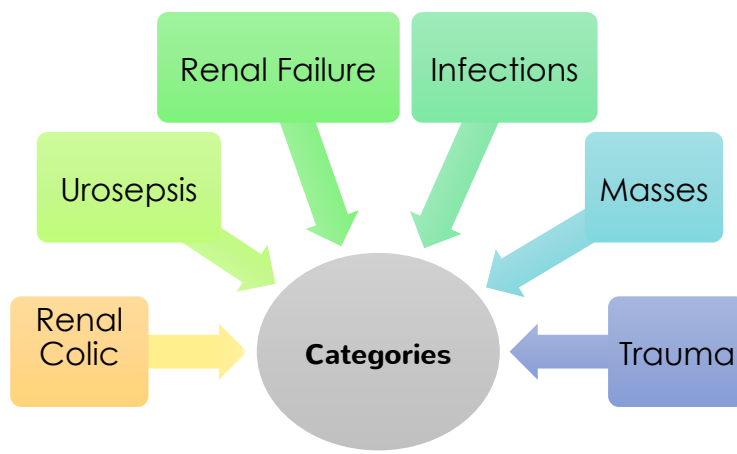
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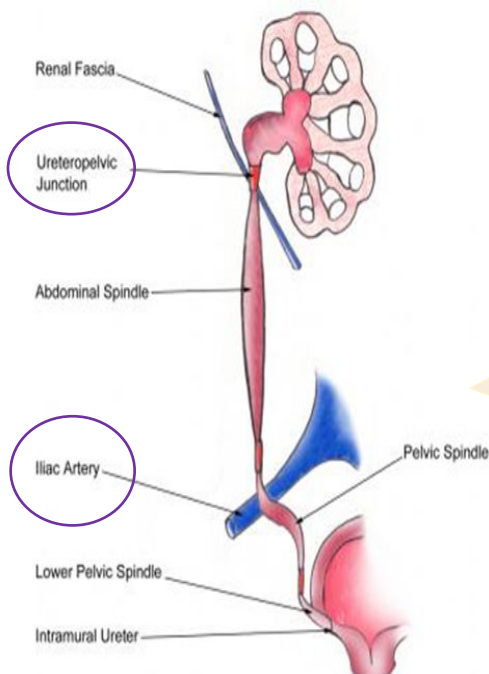
Color Index:

- **Important**
- **Females' notes**
- **Doctor's slide**
- **Explanations**



Renal Colic: It's type of pain..

- Caused by renal calculi
- Classic presentation: (sudden onset of **severe flank pain** radiating inferiorly and anteriorly +/- nausea and vomiting) this pain has been described by the patient as the **most excruciating** pain ever felt. the experienced ER physician could diagnose it just from the first moment when see the patient.
- Small, non obstructing or staghorn calculi may be **asymptomatic** or cause mild to moderate symptoms which are tolerable
- Diagnosis often made clinically
- **Imaging: to confirm and evaluate calculi**



Recall from the previous lecture, The common sites for stone obstruction :

- ❖ ureteropelvic junction
- ❖ Cross of iliac artery
- ❖ vesicourethral junction

Questions to ask:

❖ Are urinary stones present?

If so, what is the level and size? Depending on the size the management will be different either conservative medically or interventional surgery

❖ Is obstruction present?

If so, what is the level and severity? Severity: is it completely occluding the ureter and causing severe hydronephrosis? And it can cause severe sepsis which is fatal if it's ignored.

❖ Is urgent intervention required?

Factors include: urosepsis, solitary kidney*, severe pain not respond to analgesics.

*If solitary kidney should be treat it fast and take it seriously.

Treatment: percutaneous nephrostomy* or Ureteric stent.

Renal Calculi:

KUB: to assess total stone burden, size, shape, location

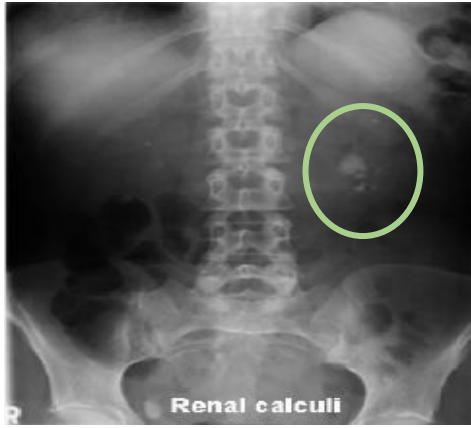
Often: US or CT is required in conjunction (it required US or CT because x-ray not enough we want to see if there is obstruction "dilation)



*insertion of a catheter through the skin and into the renal pelvis

Microscopic Hematuria

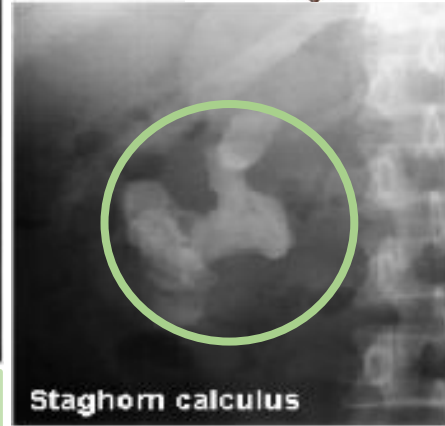
Renal stones could present with microscopic hematuria in urinalysis



Renal calculi



Gallstones



Staghorn calculus

Staghorn calculus it needs to feel at least 2 calyces and pelvis . To tell it's staghorn 😊 .

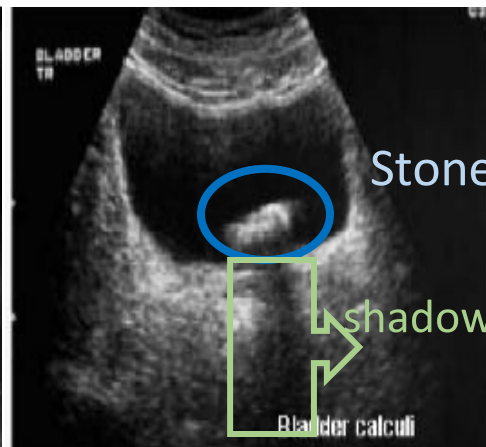
In KUB, the stone not always renal stone, it may be gallstone. if we are in doubt we do US to differentiate

It's named staghorn because resemble the staghorn of deer

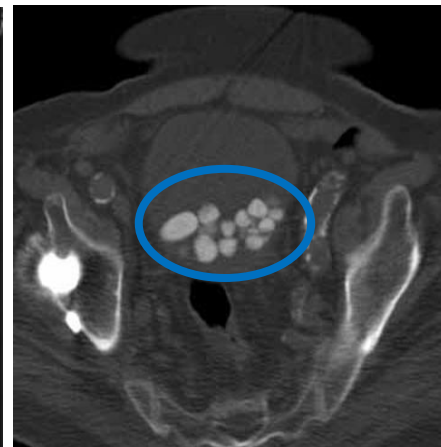
Renal Colic (cont..)



Example of bladder calculi in KUB

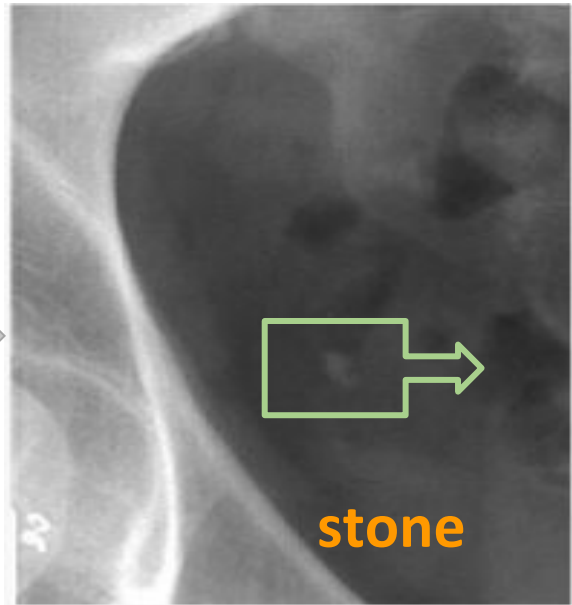
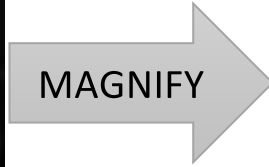
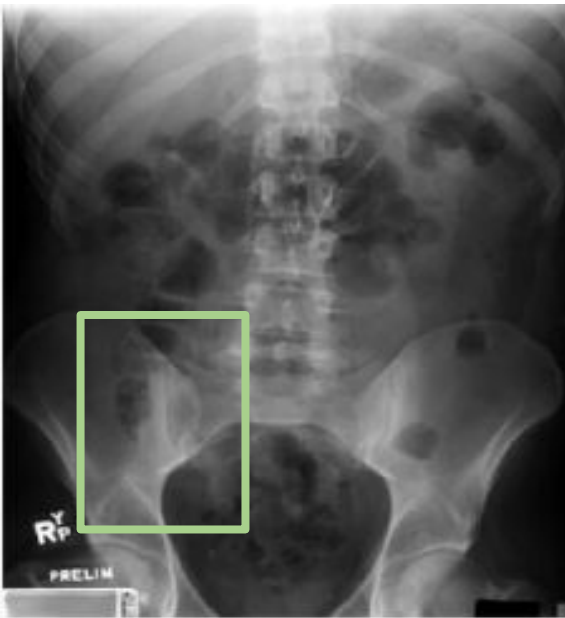


In US: hyperechogenic structure with shadow. To be sure use ultrasound, there will be a shadow.



In CT "axial section": Multiple bladder stone

Renal Colic (cont..)



Preliminary film in a patient with right renal colic, in the preliminary film if we didn't concentrate shows nothing, after concentration we see calcifications “not really calcified” so we did IVP.. Preliminary film: Imaging made before the administration of contrast material. Also called scout image



10 minutes
Delayed function
on right side



25 hours

Persistent nephrogram

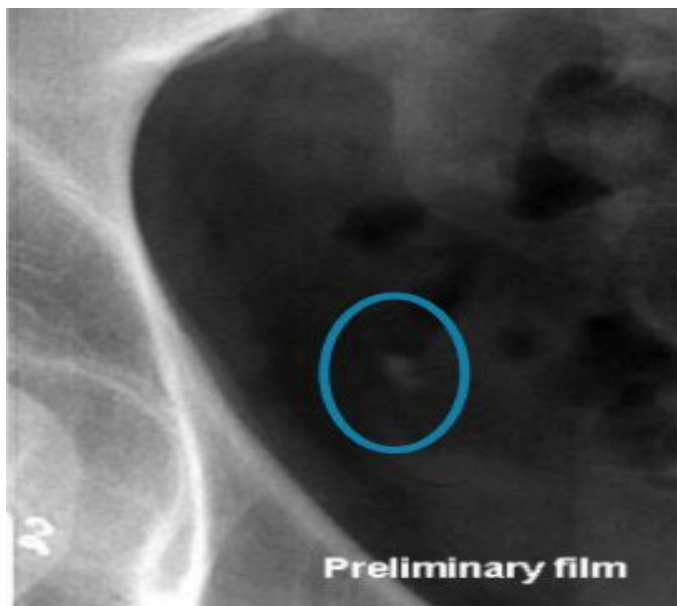


29 hours

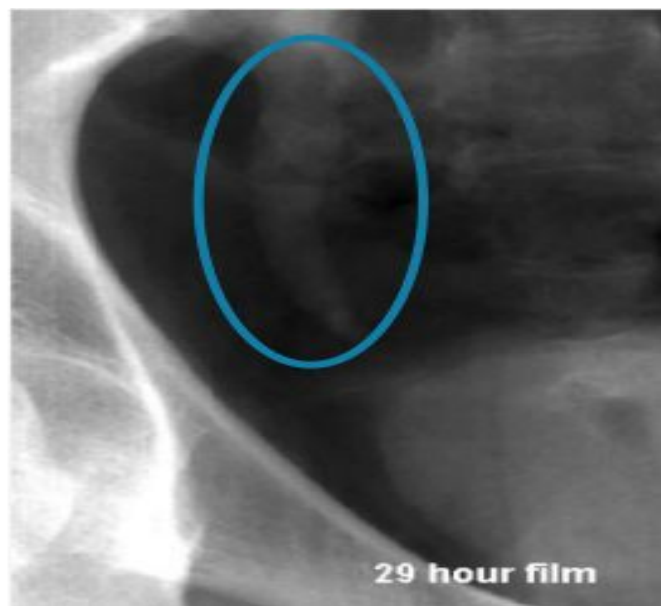
Dilated ureter to stone

- In IVP there is **delayed excretion** in the **right kidney** “you don’t see the contrast !”
- Normal excretion in the left kidney “yellow arrow, you see the contrast clearly”
- After one day there is still contrast in the right kidney so we compared it with KUB and we see the obstruction.

Radiopaque stone in distal ureter:



Radiopaque stone in distal ureter most likely at the vesicoureteral junction

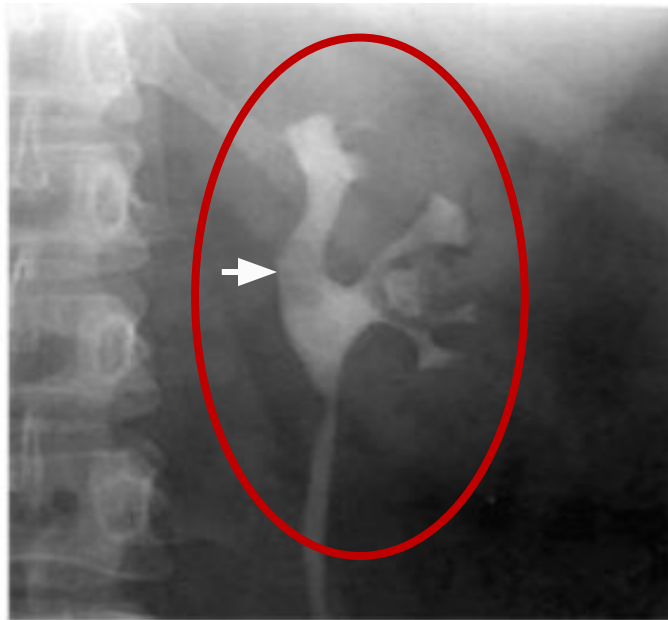


Dilated ureter

Radiolucent uric acid stones:

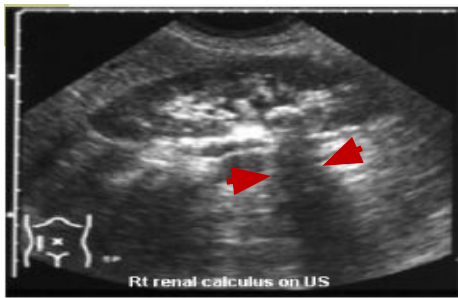


- Sometimes renal stones are not seen if they are **radiolucent like case of uric acid stones**
- What you see is bowel gas= air= black.

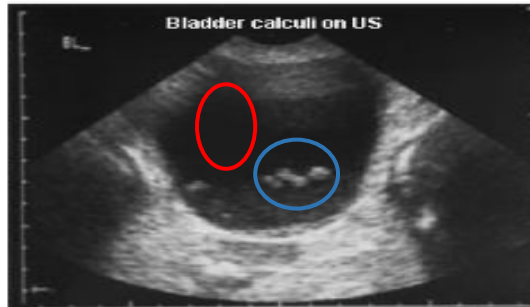
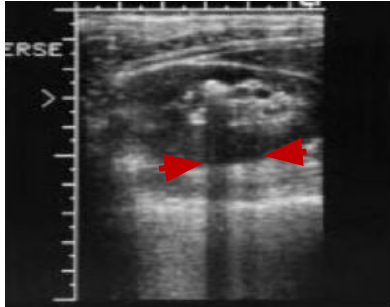
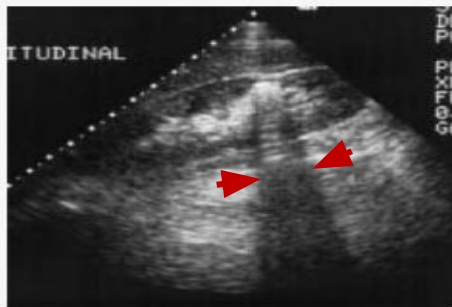


Here in the IVP we see filling defect and **dilation** of the **superior calyces** (white arrow) but middle and inferior calyces are normal .

Renal Calculus- Ultrasound:



- Renal stones in US “hyperechogenic structure” with shadow behind
- **Shadow is important** because we can't say it's stone without the shadow

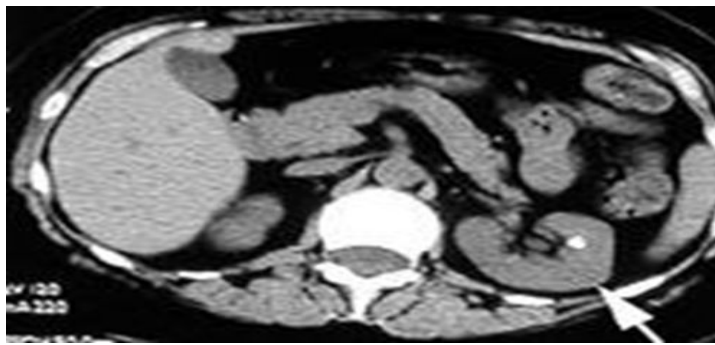


This note only for the last image: Bladder stone with some turbulent urine that could be infected. •Fluid (urine) will appear black, Stones will appear white •The reason of the absence of shadow is (the urine in the bladder is dark and the shadow is dark)

Renal Calculus- CT Scan:



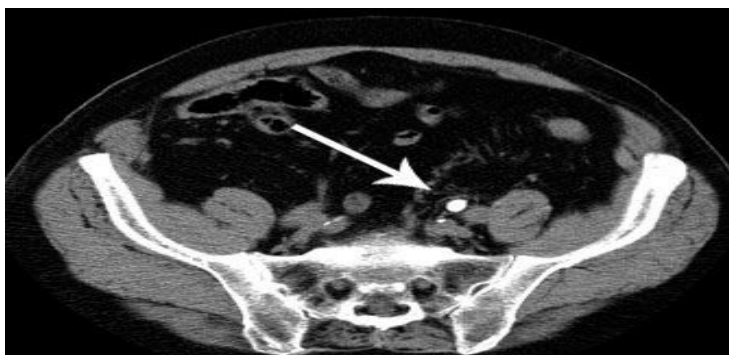
Bilateral stone with some dilatation that mean there is obstruction.



Non obstructive renal stone with no dilatation of renal uro calyceal system “pelvicalyceal”.



Example of staghorn calculus which is obstructing the pelvicalyceal system, we see it as dilatation



Example of ureteral stone obstruction

Hydronephrosis:



When you see **hydronephrosis** in CT or US that means there is obstruction.

we should review CT very carefully because sometimes when the stone is in the distal ureter, there is calcification in the **artery**, under calcification sometimes **lymph node** is calcified.

We can't differentiate (is it vessel or lymph) but this image means there is obstruction somewhere in ureter

Stones size:

- **< 4mm stone:** 80% chance of spontaneous passage
- **> 8mm :** 20% surgical intervention is required. If it's still causing symptoms we should treat it.

Management :

Medical:

- IV hydration. In ER should hydrate the patient
 - Analgesics. should alleviate the pain which is very severe either non narcotics or narcotics. They could give morphine many times and the pain still not relieved.
 - Correct hyperkalemia. hyperkalemia causes severe arrhythmia.
 - Uricosuric agents* (e.g. Allopurinol)
 - Treat UTI (prevent pyelonephrosis & urosepsis).
- If there is pyelonephritis due to obstruction they should treat it to prevent pyelonephrosis* and urosepsis which are life threatening

*medications that increase the excretion of uric acid in the urine, thus reducing the concentration of uric acid in blood plasma.

*related to the disease in the pelvis (collecting system) of the kidney.

Surgical:

- If stone > 8mm
- **Relieve obstruction** (nephrostomy or stent). Before doing anything
- ESWL (Extracorporeal Shock Waves Lithotripsy) to break down the stone into small pieces to pass easily in the urinary tract.
- Ureteroscopy
- Nephrostolithotomy. urologist use cystoscopy to see the stone and take it out Or Nephrostolithotomy done percutaneously to take stone out.
- ultrasound guidance, shows the dilated system and target the dilated calyx then put drain or the urologist could put stent through cystoscopy

Treat aggressively if solitary kidney,

Otherwise went to renal failure and dialyze for the whole life

Infections

1. Acute Pyelonephritis

- Life threatening infection & medical emergency
- Bacteria can sent Through lower urinary tract
- Early diagnosis and management has significant impact on patient outcome
- Presentation: (Fever, loin pain, nausea/vomiting)
- **pregnant women** are more prone to acute pyelonephritis
- The diagnosis of pyelonephritis is based on **clinical diagnosis but we do CT just to confirm**



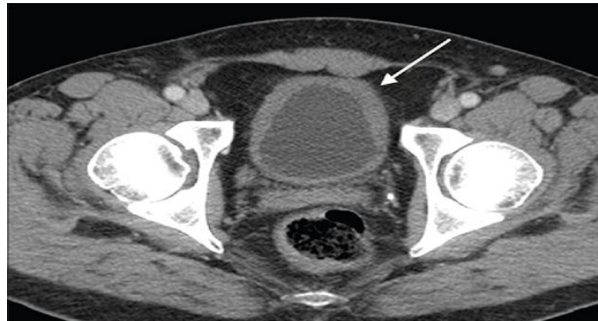
CT : Pyelonephritis: Wedge shaped hypoperfused lesion . The focus of Acute Pyelonephritis is hypofunctioning diseased of the kidney that's why it doesn't take the contrast and we can confirm that the patient has pyelonephritis . **The correlation always with clinical picture**

2. cystitis

- Presentation: (Fever, suprapubic pain, frequent urination , sometimes hematuria)
- As upper UTI, more common in females Because of short urethra



In US ; we see thick urinary bladder wall

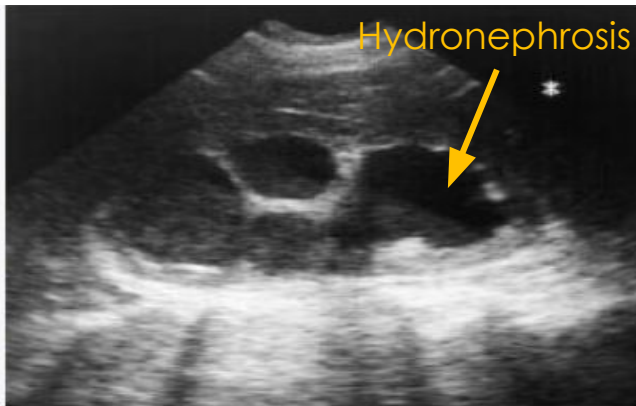


In CT : thick wall , hyperdense urine (if we took the density it will be more than liquid urea).

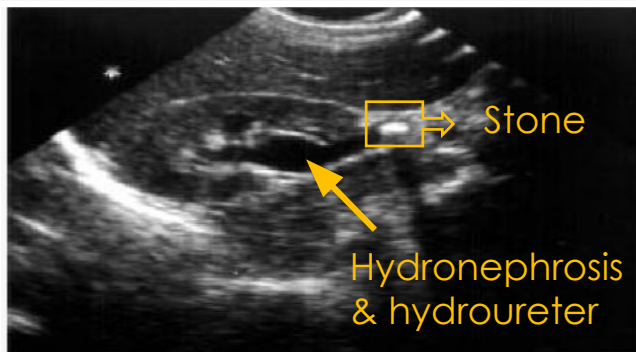
Normal density in CT:
Air= -1000 h
Fat= -60/ -120
Fluid "liquid, water"= 0-10
Bone= +1000

Urosepsis : sepsis from obstruction of infected urine

- Establish by clinical diagnosis: Pyelonephritis, cystitis, prostatitis
- Urosepsis and obstructed ureter is a urologic emergency! (If the obstruction causing dilatation which is not relieved it can cause urosepsis which is an emergency case)
- Renal US performed to rule out :
 - Renal obstruction Obstruction in US “ we should see dilatation”
 - Renal or perirenal abscess



Left pyonephrosis: Pyon: pus, nephrons: kidney. So it's infection of kidney's' collecting system. we see severe dilated pelvic calyces with echogenic content which **should be black**. But here the echogenicity means there is **pus** “calciuric sepsis”



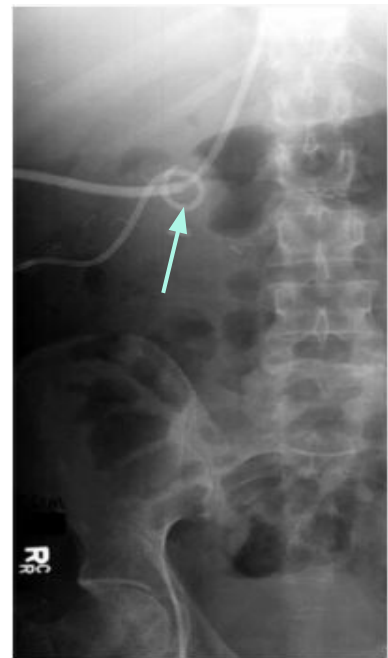
Right UPJ stone causing hydronephrosis
UPJ = ureteropelvic junction



- ❖ Ultrasound showing a right pyonephrosis and obstructing UPJ stone

echogenic content in the inferior calyces which means pus and urosepsis

- Stone causing obstruction and,
- echogenic content also
- There is pus so it cause of urosepsis.



Percutaneous nephrostomy for decompression.

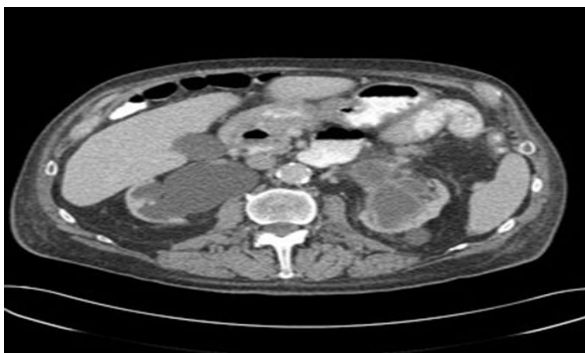
- if there is obstruction we should relieve it. Put nephrostomy to relieve the obstruction either by **antegrade** wave from the **kidney** or by retrograde wave from **urethra**
- We see dilated calyx and we targeted then put nephrostomy catheter to drain urine, we don't want the stone to obstruct and dilate the system and has back pressure effect on the kidney.

2 weeks post ESWL.

- the stone fragmented, no more stone and the dilation is released, we could remove the nephrostomy

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 go for ESWL.

Left pyonephrosis



Atrophic kidneys with severe **bilateral hydroureteronephrosis**. Hyperdense urine in **the left** renal pelvis and left ureter with wall enhancement.

Fat stranding is present around the left kidney and left ureter

- ❖ in this image we should suspect pelvic mass compress the two ureters and it has worse effect on the left side . pyelonephrosis was developed as it was chronic and long standing back pressure which not relieved.this stone was pyelonephritis which ignored and untreated so it develops pyelonephrosis.

Renal masses:

- ❖ Most renal masses are simple cysts .and we find them coincidence when we do the US for other reasons .
- ❖ Use the US to characterize the mass
- ❖ Simple cyst: STOP don't do anything it's completely benign, unless it causes compression symptoms ->we do drainage
- ❖ Solid mass or atypical cyst: CT We should do CT with contrast
- ❖ US and CT characterize > 90% of masses > 1.5 cm
- ❖ In CT if there is renal or liver mass < 1.5 cm it's difficult to characterize
- ❖ Biopsy is rarely warranted. We can diagnose it with CT

Renal cyst:

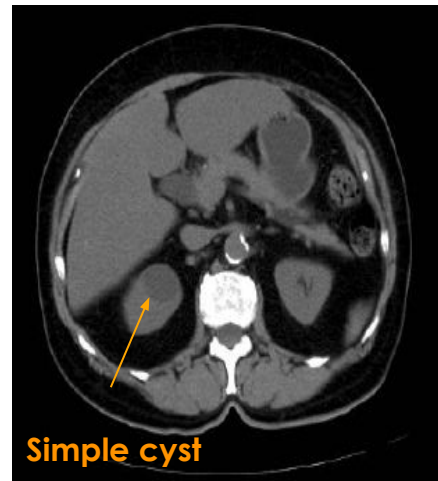
US will determine if the lesion is cystic or solid, There are two types of cysts :

1- Simple cyst

- Spherical
- echo-free fluid collection ✧ within a thin surrounding wall. no thickening, no calcification, no septation
- will show good sound wave transmission

2- complicated cyst

- will show the presence of echoes within the cyst. it's not only a simple fluid
- Will have thick wall
- And /or calcification in the wall



✧ Echo free fluid collection = anechogenic structure inside

Renal mass



Left Renal mass on IVP

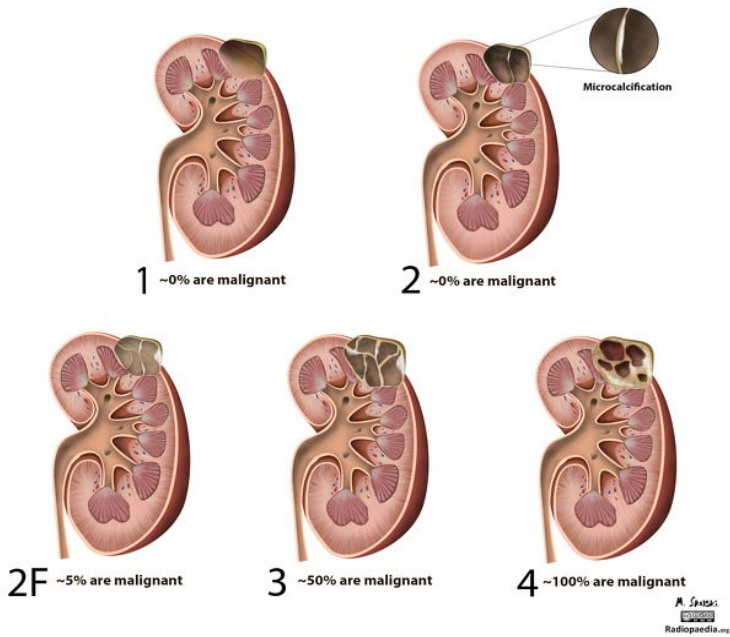
- IVP showing mass we don't know is it cystic or solid.



Simple Cyst on Ultrasound

- On US it's an echogenic so it's simple cyst

Bosniak classification of renal cysts



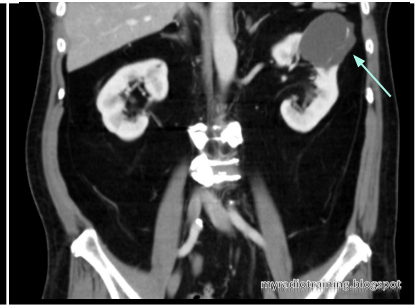
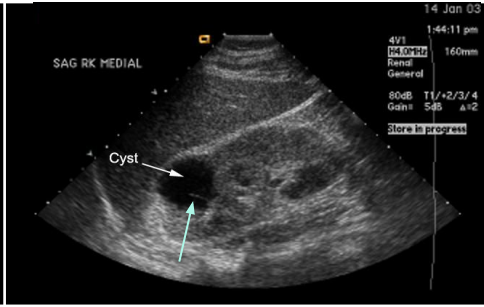
Type 1: simple cyst with thin wall and only fluid inside. Not malignant

Type 2: only one small septation. Not malignant

Type 2F: cyst between type 2 and 3, 2-3 septations, thin wall, no nodular enhancement. 5% malignant

Type 3: multiple septations with some nodular enhancement in the wall. 50% malignant

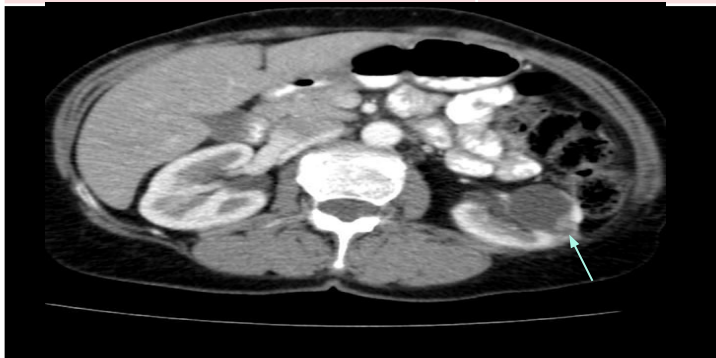
Type 4: cystic degeneration of the mass. 100% malignant



- Completely spherical.
- completely fluid content
- no septations . So, it's **Type 1.**

US shows one small .sptation, so this is **Type 2**

septation but 2-3 thin walls no nodular enhancement. this is **.Type II F**



Nodular enhancement although it's cystic and there is fluid content but we see thickened wall and calcific with enhancement. **Type 3**



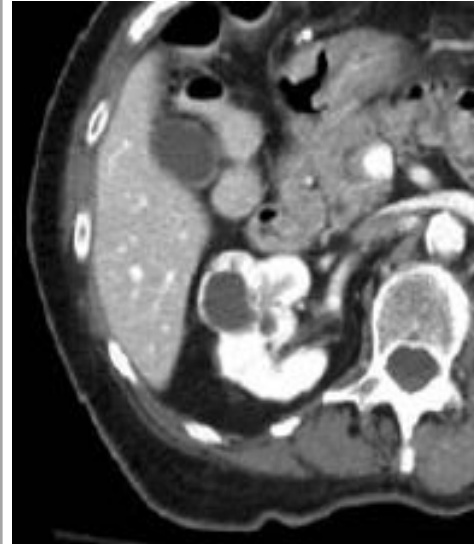
Mass in the lower pole of left kidney with enhancement of the wall, thickened wall, some **cystic degeneration.** This is malignant **Type 4.** Normally with contrast we don't see differentiation, we see all the same degree of grey.

Renal Carcinoma:

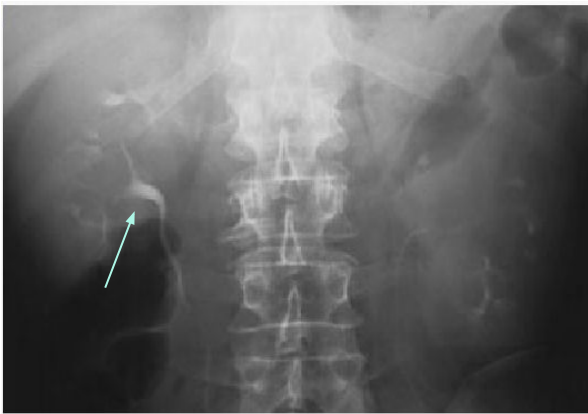
If US indicate that the mass is solid, **we must do CT** with IV contrast ✧ that can characterize the tumor in greater details – delineate extent,

- show the degree of the vascularity, is it hypervascular ?
- presence / absence of the necrotic center ,
- presence / absence of local invasion of adjacent structures “ renal vein or IVC”

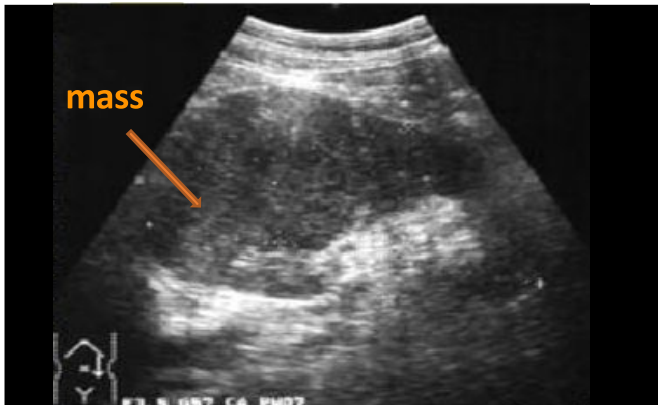
✧ If the patient with renal failure we should hydrate and we should dialyze after the procedure. IV contrast is to characterize the lesion is better.



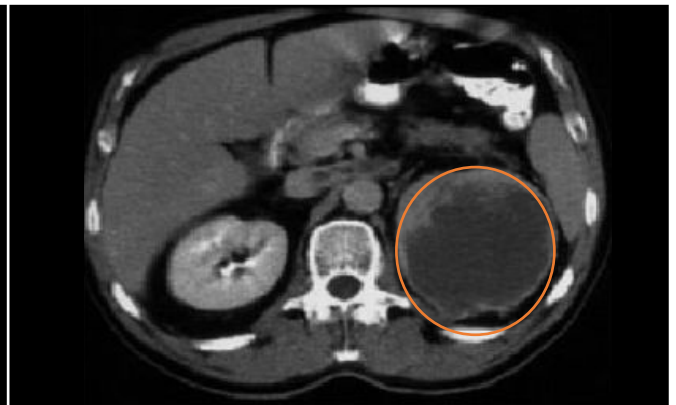
Renal mass:



- Distortion of left Pelvicalyceal System in IVP. The right kidney is normal.
- We don't see left cyst clearly this means there is mass here



US shows echogenic structure in the kidney this is not cystic, heterogeneous lesion



CT shows mass with cystic or necrotic center, enhancement here and thick wall . this is renal cell carcinoma, patient present with micro hematuria

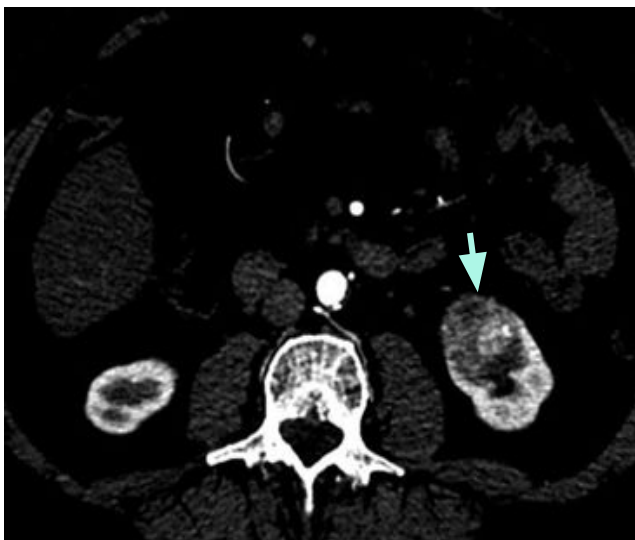
.Solid left renal mass in a patient with micro hematuria

Renal adenocarcinoma:

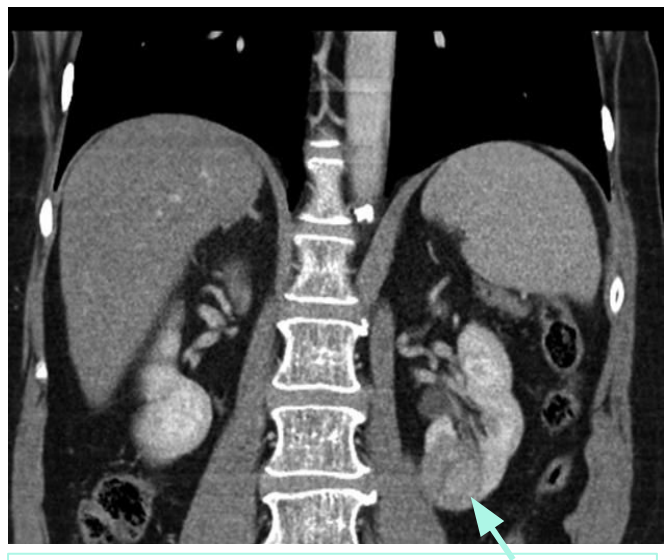
- 90% of all renal malignancies .
- 15-30% metastatic at diagnosis . * It has good prognosis if discovered in stage 1 , 5 years survival rate is more than 80%
- Hematogenous and lymphatic spread
- 10% have venous invasion (renal vein or IVC)
- Treatment :
- Radical Nephrectomy . *mostly it's the treatment of choice
- partial Nephrectomy .

- Appropriate imaging workup: After we discover renal cell carcinoma we should do work up to see if there is metastasis.
- chest X-ray : pulmonary metastases or better to do Pulmonary CT to see pulmonary metastasis
- CT abdomen : local invasion , lymphadenopathy , venous extension .
- MRI abdomen : renal failure, Contrast allergy. MRI is used if the patient allergic to the contrast or have renal failure.

70 y/o female presented with painless hematuria:



Upper pole lesion of the Left Kidney



Heterogeneous with enhanced part in lower pole so this is:

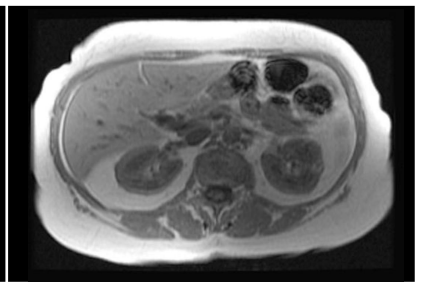
- renal cell carcinoma
- No invasion
- Some effective mass on the left psoas

Renal Angiomyolipoma:

- Benign hamartomatous tumor comprised of fat , smooth muscle and vessels. Angio= vessels, myo= muscle, lipo= fat & oma= benign tumor.
- Usually asymptomatic .
- Occasionally present with hemorrhage when large or multiple . we can see it only if there is hemorrhage with this mass when it's large or multiple and we have to embolize it to control this hemorrhage.
- Fat detected in 96% by CT . (usually do not need surgical intervention).



example of angiomyolipoma in US hyperechogenic Cortical rounded structure which is fatty



When we measure density here it was -30. and hyper seen in MRI.

Transitional Cells Carcinoma "TCC":

- most common malignancy of ureter and bladder
- < 10% of renal malignancies .
- Typically present with **gross hematuria** .
- CT for staging and surgical planning
- Treatment : radical nephrectomy.



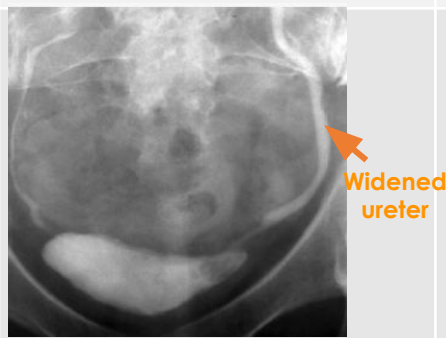
IVP and retrograde pyelogram TCC proximal left ureter .IVP show distortion of part of the ureter with ureteropelvic junction obstruction and dilatation. TCC was discovered here in left proximal ureter as filling defect.



Large TCC of the right renal pelvis
Seen as filling defect.



- IVP and pelvic CT –large TCC of bladder obstructing right ureter.
- IVP shows severe dilatation of pelvicalyceal system in right side with filling defect in the right side of the bladder due to obstruction.
- We see the mass in the CT: TCC of the bladder, small one in the left side with dilatation of ureter “ you see the filling defect”. Patient present always with hematuria



- Small TCC of bladder in patient with hematuria.
- Small bladder mass with dilatation of the ureter .



- Bladder TCC in tow patient
- Seen as hyper echogenic structure attach to the bladder wall

Acute and Chronic Renal Failure:

-clinical categories :

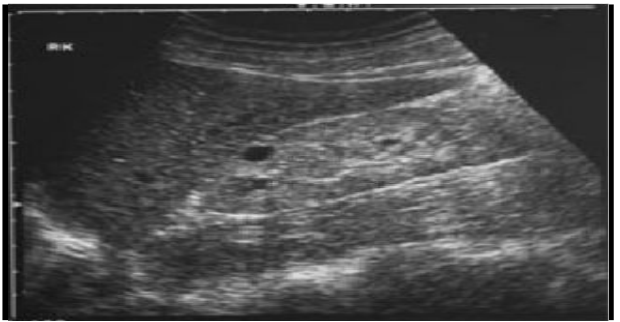
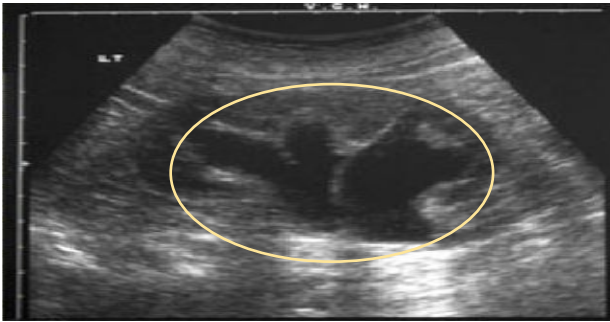
- prerenal (dehydration , shock , cardiac failure)
 - Renal (parenchyma , diabetes , GN , drugs , renovascular)
 - Postrenal (obstruction, by chronic mass or chronic stone or malignancy)
- IV contrast **contraindicated** if creatinine >200 mmol/dl or the clearance is less than 30 ml/min. Sometimes if patient is 90 years old they should be careful when they give the contrast because may develop renal failure so we should hydrate very well and give HCO₃

-Use US to assess :

- Renal size “with renal failure the kidney is atrophic & thinning in the cortex
 - Parenchymal thickness
- US guided renal biopsy to establish diagnosis.

Cont...Acute and Chronic Renal Failure:

Acute	Chronic
kidney is enlarged in size	kidney is small in size
oedematous	No darkness in the cortex
obstruction	Bright echo pattern
	cysts can be seen.



Hydronephrosis post-renal

- Acute, surgically treated
- Post-renal obstruction will lead to renal failure.

Atrophic , echogenic kidney "Medical renal disease"

- No differentiation between the cortex and medulla
- Medical renal disease (not surgical, treat underlying disease e.g. DM, HTN, glomerulonephritis, congenital dis...)

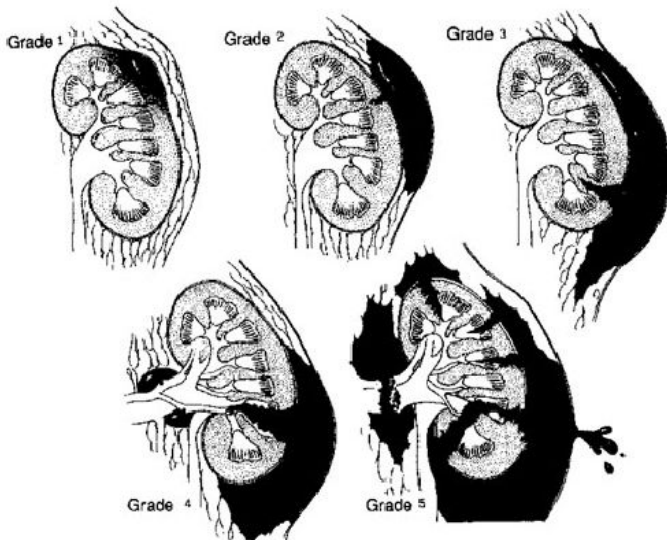
GU Trauma

Penetrating Trauma (gunshot, stab)

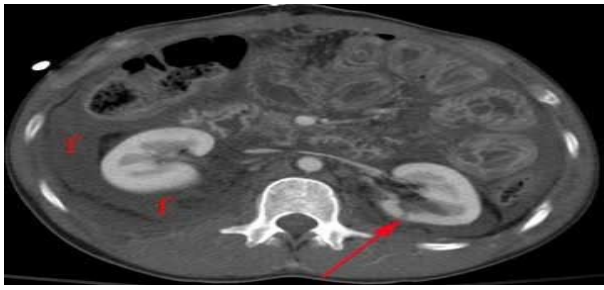
-Unstable -> surgery or angiography (if there is extravasation of contrast we should embolize)

-stable -> CT (used to grade the injury)

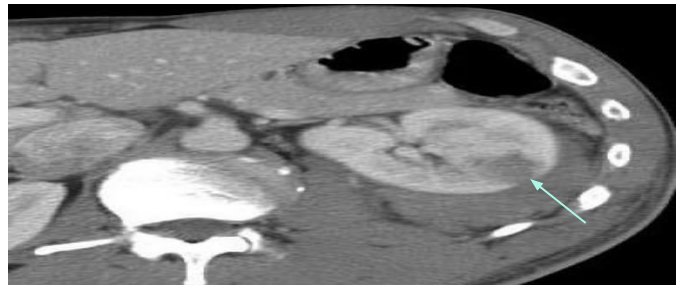
RADIOGRAPHIC ASSESSMENT OF RENAL TRAUMA



Grade 1	Hematoma, only contusion of kidney
Grade 2	Hematoma enter cortex ,laceration in the cortex <1cm
Grade 3	>1 cm but not extending into collecting system
Grade 4	Extend to renal pelvis extending to the collecting system
Grade 5	Shattered kidney completely around the kidney



Grade 1-2 injury. filling defect means laceration



Grade 3 injury. Not extending to the collecting system, hypodense non enhanced area in patient with trauma history.



Grade 4 injury: deep laceration with perirenal hemorrhage, injury extending to the collecting system and there is perirenal hemorrhage and hematoma



Grade 5 injury: thrombosed renal artery
Kidney non enhanced at all there is thrombosis of right renal artery which completely cut down in angiography we don't see the right kidney at all. "arrow"

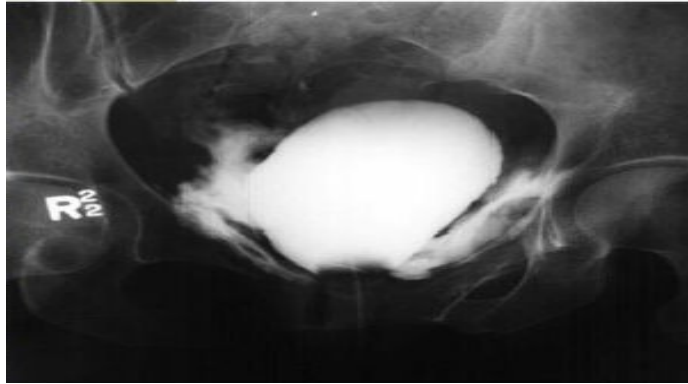
GU trauma:

Bladder injury either extraperitoneal or intraperitoneal. In trauma patient we see blood at urethral meatus we should do retrograde cystography "Inject contrast by retrograde catheter" will see the contrast either extra or intra peritoneal.



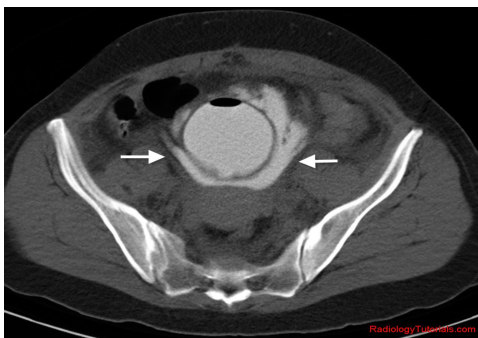
Intraperitoneal bladder rupture

- Surgical management
- Intraperitoneal we see the contrast over the peritoneum and intraperitoneal bladder rupture usually in pediatric age group when bladder still in the abdomen



Extraperitoneal bladder rupture

- Just apply catheter to drain, until the body heal the injury



Ct showing bladder injury with contrast all over around the bladder and this is extraperitoneal



Normal retrograde urethrogram, we see all parts of urethra



Traumatic rupture of bulbous urethra. The contrast drained out of the urethra.

Don't Forget !

- Small, non obstructing or staghorn calculi may be asymptomatic or cause mild to moderate symptoms which are tolerable

- Diagnosis often made clinically

- Imaging: to confirm and evaluate calculi

- urgent cases: urosepsis, solitary kidney*, severe pain not respond to analgesics.

- In US: hyperechogenic structure with shadow. To be sure use ultrasound, there will be a shadow.

- radiolucent like case of uric acid stones

- **hydronephrosis** in CT or US that means there is obstruction.

- medical intervention includes: hydration, Analgesics, correction of hyperkalemia, Uricosuric agents, Treat UT

- **pregnant women** are more prone to acute pyelonephritis

- US will determine if the lesion is cystic

- or solid

-

-

- In renal failure IV contrast contraindicated if creatinine >200 mmol/dl

- US and CT characterize > 90% of masses > 1.5 cm

- there are 2 types of renal cyst: simple and complicated

- Bosniak classification of the renal cyst

- Most renal masses are simple cysts

- 90% of all renal malignancies are renal adenocarcinoma

- **Renal Angiomyolipoma** Occasionally present with hemorrhage when large or multiple

- TCC: most common malignancy of ureter and bladder, with gross hematuria