

Urinary Calculi (Lecture 1)

Aim

At the end of the lectures, the students should be able to:

- 1- Identify the main risk factors for urinary calculi formation.
- 2- Recognize those patients with urinary calculi who needs urgent intervention from those who manage conservatively.
- 3- Identify the main options in the management of various types of urinary calculi.

Definition

Urinary stone is a polycrystalline aggregate.

Aetiology

1. Dietetic:

High energy-dense diet may increase the incidence of urinary calculi.

High sodium intake and vitamin A deficiency also increase the incidence of urinary calculi.

2. Altered urinary solutes and colloids:

-Dehydration

-Reduction of urinary colloids which adsorb solutes

3. Decreased urinary citrate

4. Renal infection: urea-splitting Streptococci, Staphylococci and especially Proteus spp.

5. Inadequate urinary drainage and stasis

6. Prolonged immobilisation

7. Hyperparathyroidism

8. Occupation: Pts with Sedentary works have higher incidence of urinary stones.
9. Climate: Individuals living in a hot climate are more prone to dehydration which increase the incidence of urinary stones.
10. Family hx.: also increase its incidence.
11. Medications: as Indinavir, and triametrene.
12. Structural and anatomical abnormalities of the urinary tract.

Theories of stone formations:

For stone formation to occur , urinary crystals and matrix should be intertwined.

1- Nucleation theory:

It states that stone originates from F.B. immersed in supersaturated urine.

2- Matrix theory:

It postulates that matrix may act as a nidus for crystal aggregation or as a natural glue to adhere small crystals.

3- Crystal inhibitor theory:

It claims that calculi form owing to the absence or low concentration of urinary stone inhibitors.

Stone Varieties

1) Calcium calculi:

It account for 85% of urinary stones. it includes calcium oxalate and calcium phosphate calculi. it is formed due to either:

- a. ↑ urinary calcium excretion (Hypercalciuria) : which is either(absorptive, resorptive or renal induced).
- b. ↑ urinary uric acid excretion (Hyperuricosuria).
- c. ↑ urinary oxalate excretion (Hyperoxaluria).
- d. ↓ urinary citrate excretion (Hypocitraturia).

Calcium Oxalate Calculi

- irregular in shape
- sharp projections
- The surface covered with altered blood
- Ca oxalate monohydrate is hard & radiodense.

2-Uric Acid Stones

- It accounts for less than 5% of all urinary calculi.
- They are usually formed in male patients with gout, rapid weight loss and those with myeloproliferative diseases.
- Those patients usually have urinary $\text{pH} \leq 5.5$
 - Uric acid stones are:
 - smooth& often multiple.
 - Vary from yellow to reddish brown & st have attractive, multifaceted appearance.
 - Pure UA stones are radiolucent
 - Most of them contain some Ca, so they cast a faint radiological shadow.
 - In children, mixed stones of ammonium and sodium urate are st found. They are yellow, soft, & friable.

3-Struvite Stones

composed of magnesium , ammonium and phosphate (MAP). It frequently found & tends to grow in alkaline urine so it is more common in women with recurrent U.T.I. with urea splitting organisms. They are smooth and dirty white

- may form staghorn
- may be clinically silent
- Easy to see on radiographic films

4-Cystine Stones

-usually secondary to inborn error of metabolism.

-Uncommon

-Hexagonal, translucent, white crystals

-Appear in acidic urine

-Often multiple

-May form staghorn

-Pink or yellow when first removed , they change to green when exposed to air.

-They are opaque because they contain sulphur

-Very hard

5-Xanthine Stones

-usually secondary to deficiency of xanthine oxidase enzyme.

-Extremely rare

- Smooth& round
- Brick-red colour
- Show lamellation on cross - section

6) Other rare stones: as Indinavir ,Silicate and Matrix stones.

| X-ray characteristics | | |
|------------------------------|------------------------------|----------------------|
| Radiopaque | Poor radiopaque | Radiolucent |
| Calcium oxalate dihydrate | Magnesium ammonium phosphate | Uric acid |
| Calcium oxalate monohydrate | Apatite | Ammonium urate |
| Calcium phosphates | Cystine | Xanthine |
| | | 2,8-dihydroxyadenine |
| | | 'Drug-stones' |

The most important phosphates involved in urinary stone disease are carbonate apatite, brushite, and struvite. Brushite stones (i.e. calcium monohydrogen phosphate, $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$). Brushite is considered the precursor phase of hydroxyapatite. If brushite does not convert to hydroxyapatite, brushite stones will form.

Clinical Features

- Approximately 50% presents between 30-50 yrs

1. Silent calculi: uremia may be the first indication of bilat. Calculi , although secondary infection usually produces symptoms first.

2. Pain:

- Leading symptom in 75%

3.Hematuria

Is st a leading symptom of stone dz & occasionally the only one

4. Irritative voiding symptms: as dysuria,frequency and or urgency especially in the presence of infection or stone in the uretero-vesical junction.

5. Non urinary symptoms: as nausea, vomiting and or abdominal distension.

6. Anuria or oliguria with signs and symptoms of renal failure especially in :

- a.Bilateral staghorn stones
- b. Bilateral ureteral stones or
- c. Stone obstructing single kidney

O/E

1.During attack of ureteric colic there is rigidity of lat. abdominal muscle but not as a rule, of rectus abdominis.

2.Percussion over kidney produces a stab of pain & may be tenderness on deep palpation

3.Palpable loin swelling is rare due to hydronephrosis or pyonephrosis.

Lab. Investigations and Diagnosis:

After careful medical and surgical history and thorough physical examination then lab. Ix. and imaging studies are used to ensure the dx. and include:

1. Urinalysis (G.U.E.): Look for RBC,WBC,Crystals,casts and pH.
2. Blood ix.: as B.urea, S.creatinine.

Imaging studies include:

1.K.U.B.: To look for radio opaque shadows. About 90% of renal stones are radio opaque. The most radiolucent stones are pure uric acid stones, pure cystine stones and matrix stones.

DDX of Opacities on plain abdominal radiograph that may be confused with renal calculi:

- 1.Calcified mesenteric L.N
- 2.Gall stones or concretion of appendix.
- 3.Tablets or F.B in the alimentary canal.
- 4.Phebolith.
- 5.Ossified tip of 12th rib.
- 7.Calcified T.B lesion in kidney.
- 8.Calcified adrenal gland.



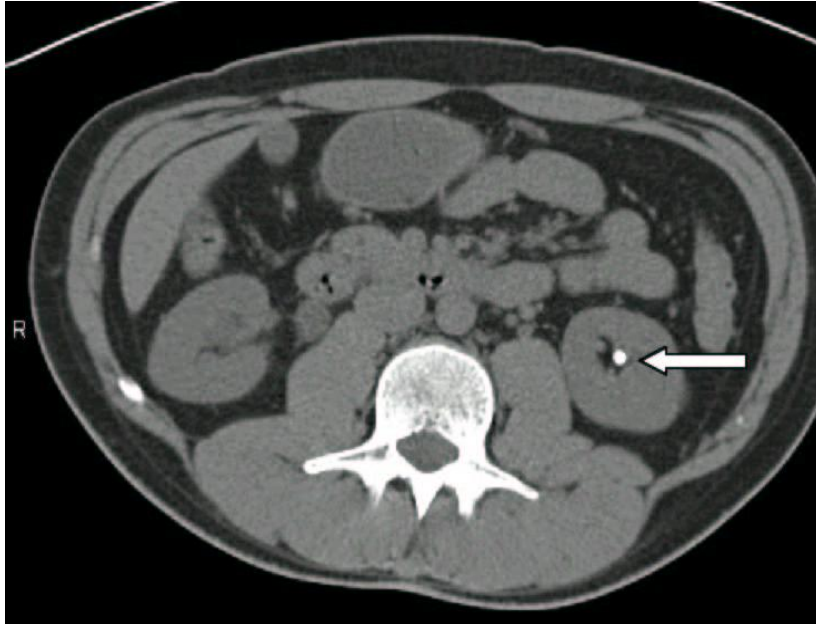
2. I.V.U.(EU): to look for filling defects and give an idea about the renal function.

3. Abdominal ultrasound

4. CT-scan : helical CT-scans are now the imaging modality of choice for patients presenting with acute ureteric colic,

While M.R.I. is a poor study for documentation of urinary stones.

5. Nuclear scintigraphy.



TRT of Renal Stones (2nd Lecture)

1. Conservative TRT

a. Increase fluid.

b. Dissolution agents: oral alkalinizing agents which include Na or K bicarbonate and k citrate.

2. Extracorporeal Shock Wave Lithotripsy(ESWL): It is the treatment of choice for those patients with renal stones, size(<25 mm) and those with failed conservative treatment.

***Contra indications :**

- 1. Pregnancy.**
- 2. Large abdominal aneurysm.**
- 3. Uncorrectable bleeding disorders.**

3. Percutaneous Nephrolithotomy(PNL):

It is antegrade instrumentation of the upper urinary tract via percutaneous puncture.

It is indicated for:

- a. Big renal stones (≥ 25 mm).
- b. Distal obstruction not caused by the stone such as PUJ obstruction.
- c. Stone in calyceal diverticulum.
- d. Lower pole renal stones where the success of ESWL is low.
- e. when there is contra indication for ESWL.

***Various types of lithotripters can be used for destruction and removal of renal stones as pneumatic, ultrasonic or laser probes lithotripters**

4.RIRS(Retrograde Intrarenal Surgery):

By using Flexible ureteroscopy and laser

5.Laparoscopic pyelo and uretero- lithotomy.

6-Open Surgery

- a.Pyelolithotomy
- b.Nephrolithotomy
- c.Partial Nephrectomy.

TRT of Ureteral Calculi:

1. Spontaneous passage depends on stone size, site, shape & associated ureteral

oedema.

-Ureteral calculi 4-5mm have 40-50% chance

-Calculi >6mm have <5% but this does not mean that a 1cm stone will not pass.

-Lower Ureteric stones have 50% chance of spontaneous passage.

-Midureteric stones (25%).

-Proximal Ureteric stones(10%).

2.Medical Expulsive Therapy:

1.NSAID: Diclofenac & Indomethacin.

2.PDE-5 Inhibitors like Tadalafil

3.Alpha-blockers: Tamsulosin

4. Ca channel blockers: Nifedipine.

3.ESWL

4.Endoscopic Stone Removal:

a.Dormia basket

b.Ureteric meatotomy.

C.Ureteroscopy.

5.Open surgery (Ureterolithotomy) and laparoscopic ureterolithotomy.

Indications of Surgical and endoscopic Intervention of Ureteric Stone:

- a. Repeated attacks of pain and stone is not moving.
- b. Stone is enlarging.
- c. Complete obstruction of kid.
- d. Urine is infected.
- e. Stone is too large to pass.
- f. Stone is obstructing solitary kid. Or there is bilat. Obstruction.

A pt with obstructive ureteral calculi with fever requires emergent drainage like by placement of DJ stents or P/C nephrostomy.

Bladder Stones

Primary= Develops in sterile urine & often originate in kidney.

Secondary= occurs in presence of infection, outflow obstruction, impaired bladder emptying, or F.B.

Clinical Features

Men are affected 8 times more frequently than women. A solitary bladder stone is the rule, but there are numerous stones in 25% of Pts. Stone analysis frequently reveals ammonium urate, UA, or Ca oxalate.

Symptoms= Frequency, sensation of incomplete emptying, pain(strangury), it occurs at end of micturition and referred to tip of penis or labia majora, more rarely referred to perineum or suprapubic region.

In children screaming and pulling at penis with hand at end of micturition are indicative. Hematuria, interruption of urinary stream. Infection is a common presenting symptom.

O/E

1. May be normal
2. May be suprapubic tenderness.
3. Vaginal exam.: **occasionally** large calculus is palpable in female.

Treatment options for bladder calculi:

1. Endoscopic vesico - litholapaxy :

By cystoscope with use of various types of lithotripters as mechanical, ultrasonic, electrohydrolic or laser lithotripters.

2. P/C Suprapubic Litholapaxy.

3. Open vesicolithotomy .

Urethral stones :

- **Small stones** near the external meatus can be grasped with a grasper.

- **Large and posterior urethral stones** can be pushed to the bladder and removed endoscopically.

Prevention

In bilateral & recurrent stone formers:

1.S.Ca

2.S.UA

3. Urinary urate, Ca, & Phosphate in 24 hr collection, & urine should be screened for cystine.

4. Analysis of any stone passed.

5. Dietary advice

6. Drink plenty of fluid.

7. Drug TRT: is largely ineffective except in those who are shown to have idiopathic hypercalciuria: Bendroflumethiazide 5mg.

End of 2nd Lecture

