

Urinary Calculi (Lecture 1)

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Learning objectives

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

- 1- Identify the main risk factors & how the urinary stones are formed.
- 2- Know the types of urinary calculi.
- 3- Diagnose the condition (history, physical examination, investigations, & imaging).
- 4- Know different methods of treatment & recognize those patients with urinary calculi who need urgent intervention.
- 5- Know the complications of urinary stones.
- 6- Know how to prevent stone recurrence.

Pretest: Prepared

1. Which of the following is NOT a recognized risk factor for kidney stone formation?

- a. Residence in certain parts of the United States, including the Carolinas, Georgia, and Alabama
- b. Low fluid intake
- c. High animal protein intake
- d. High calcium diet

2. Which of the following medications should NOT increase the risk of kidney stone formation?

- a. Acyclovir
- b. Furosemide
- c. Acetazolamide
- d. Hydrochlorothiazide

3. Which of the following strategies would NOT prevent nephrolithiasis recurrence in a patient with uric acid stones?

- a. Allopurinol use
- b. Targeting a urine pH less than 5.5
- c. Low-sodium diet
- d. Potassium citrate supplementation

4. Obesity is a known risk factor for nephrolithiasis. Therefore, weight loss/bariatric surgery reduces the risk of calcium oxalate stone formation.

False

True

5. JW has a medical history of long-standing Sjogren syndrome. She's currently experiencing her second episode of nephrolithiasis. Your metabolic evaluation revealed the possibility of calcium

phosphate stones. Which of the following interventions would NOT reduce the risk of future stone recurrence?

- a. Start high calcium diet
- b. Start thiazide diuretic
- c. Start potassium citrate and aim for urine pH above 7
- d. Increase fluid intake to 2L per day

6. Percutaneous nephrolithotomy monotherapy is the treatment of choice for staghorn calculi.

False

True

7. Who are more susceptible to kidney stones?

- a. Men in the third and fourth decades of life
- b. Women in the third and fourth decades of life
- c. Children
- d. Adult

8. Which is the most common type of kidney stones?

- a. Struvite stones

- b. Calcium stones
- c. Uric acid stones
- d. Cystine stones

9. What causes kidney stones?

- a. Faulty diet
- b. Metabolic diseases
- c. Urinary tract infections
- d. Family history of stones
- e. All of the above

10. Which are the common symptoms of kidney stones?

- a. Severe back or abdominal pain
- b. Nausea and vomiting
- c. Kidney stones may be symptomless
- d. All of the above

11. Which of the following measures help to prevent kidney stones?

- a. Drinking plenty of water
- b. Less coffee, grape juice
- c. Cut down salt and sodium intake
- d. a, b and c
- e. Cut down medications

12. Which of these tests help to diagnose kidney stones?

- a. CT scan
- b. Intravenous pyelogram
- c. Retrograde pyelogram
- d. Urine analysis
- e. All of the above

13. Once a person forms a stone what are the lifetime risk of forming another stone within 10 years.

- a. 10%
- b. 30%
- c. 50%
- d. 70%
- e. 100%

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).

The most important **phosphates** involved in urinary stone disease are carbonate apatite, brushite, and struvite.

Ca Phosphate Stones: 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.

Calcium Oxalate Calculi

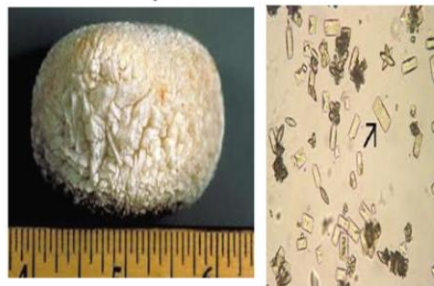


- irregular in shape
- sharp projections
- The surface covered with altered blood
- Ca oxalate monohydrate is hard & radiodense.

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.

Uric acid stone and shape of its crystals in urine



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

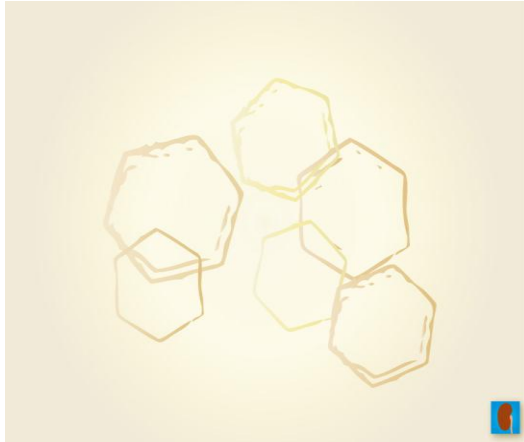
-Often multiple

-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 symptoms: 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. Phlebolith.
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.

