Renal Stones

Urolithiasis

Kidney Stones

Renal Calculi

Nephrolithiasis

Lecture 50

Renal Stones

Renal Stones

A **kidney stone**, is a solid concretion or crystal aggregation formed in the kidneys from dietary minerals in the urine.

Classification- by location

- Urinary stones are typically classified by their location in the
- kidney (nephrolithiasis),
- ureter (ureterolithiasis),
- bladder (cystolithiasis),

Classification - by chemical composition

1. Calcium salts
2. Uric acid
3. Mg ammonium PO_4
4. Cystine
5. Other (xanthine, etc.)

Causes

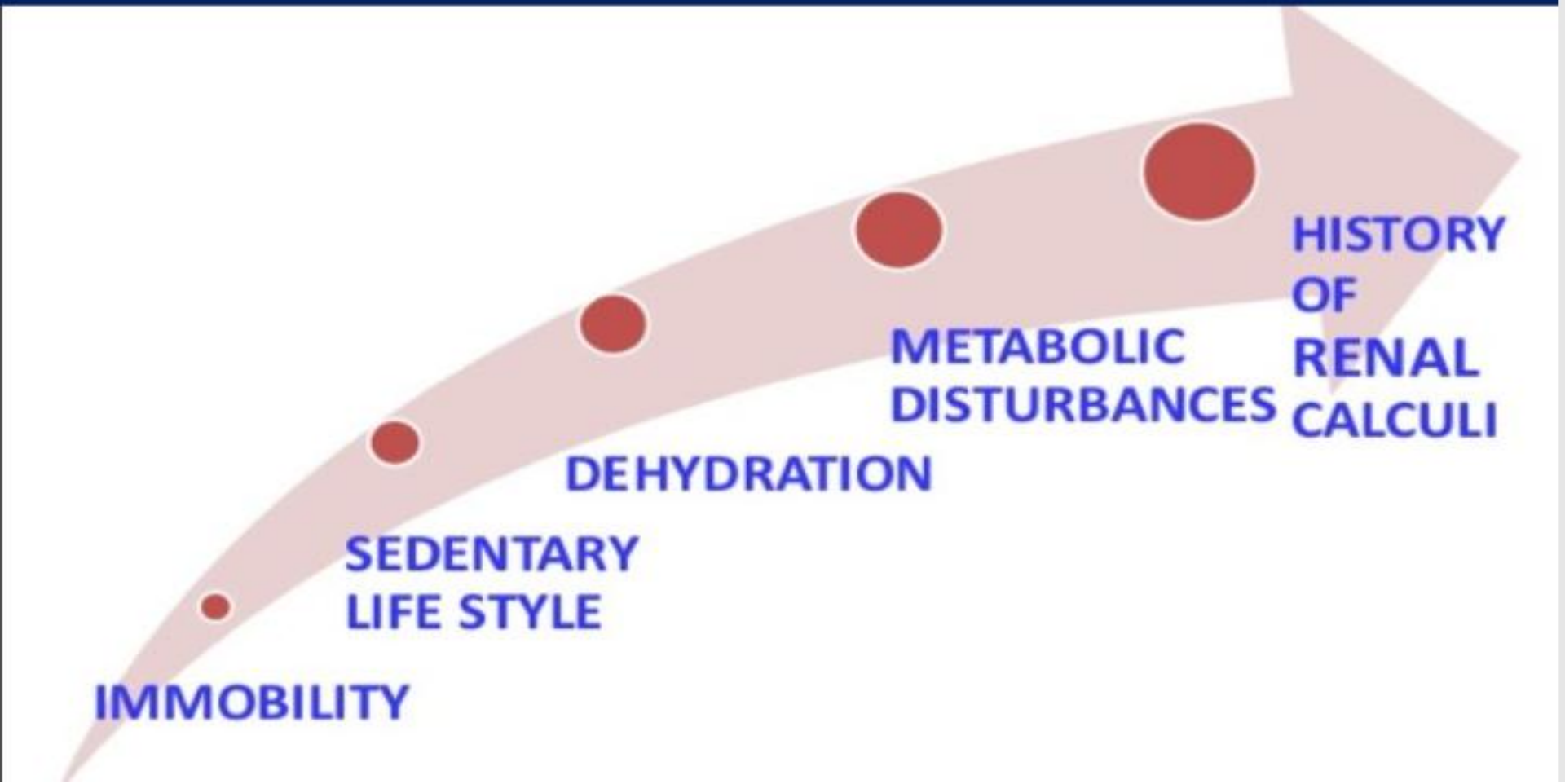
- METABOLIC
- LIFESTYLE
- GENETIC FACTORS
- DRUGS
- OTHERS

Dietary Causes

- LOW FLUID INTAKE
- HIGH DIETARY INTAKE OF ANIMAL PROTEIN,
- SODIUM,
- REFINED SUGARS, FRUCTOSE
- HIGH FRUCTOSE CORN SYRUP,
- OXALATE,
- GRAPEFRUIT JUICE
- APPLE JUICE

higher Vitamin C

Risk Factors



Risk Factors

- HIGH MINERAL CONTENT IN DRINKING WATER
- DIETARY INTAKE
- UTI & H/O FEMALE GENITAL MUTILATION
- PROLONGED INDWELLING CATHETERISATION
- NEUROGENIC BLADDER

Risk Factors

- Male sex
- Obesity
- Family History
- H/o stone disease (1/2 will have recurrence)

Risk Factors

- Occupation
- Small bowel disease (i.b.d.)
- Medical conditions causing hypercalcuria
- Medical conditions causing aciduria

PATHOGENESIS-
MUCOPROTEIN MATRIX

- An organic

mucoprotein matrix,

making up 1% to 5% of the stone by weight, is present in all calculi.

PATHOGENESIS- SUPERSATURATION

The most important determinant(Renal stones) is an increased urinary concentration of the stones' constituents, such that it exceeds their solubility (supersaturation).

A low urine volume in some metabolically normal patients may also favor supersaturation.

Supersaturation- Slow urine flow

- **Slow urine flow, resulting in supersaturation of the urine with the particular element that first become crystallized and later become stone**

SOLUBILITY

- Solubility is affected by
- **Urine pH,**
- **Volume** and
- **Total excretion**

Calcium salt stones

- 80% of kidney stones contain calcium
- The type of salt depends on
  - Urine pH
  - Availability of oxalate
- General appearance:
  - White, hard, radioopaque
  - Calcium PO_4: staghorn in renal pelvis (large)
  - Calcium oxalate: present in ureter (small)

Pathogenesis- Calcium Oxalate Stones Hypercalcemia & Hypercalciuria

- *Calcium oxalate stones* are associated in about **5%** of patients with *hypercalcemia* and *hypercalciuria*, such as occurs with hyperparathyroidism, diffuse bone disease, sarcoidosis, and other hypercalcemic states.

Pathogenesis 55%

Hypercalciuria without hypercalcemia

- This is caused by several factors, including:
- Hyperabsorption of calcium from the intestine (Absorptive hypercalciuria),
- Intrinsic impairment in renal tubular reabsorption of calcium (Renal hypercalciuria),
- Idiopathic fasting hypercalciuria with normal parathyroid function.

Calcium salt stones

Causes of calcium salt stones:

- Hypercalciuria:
  - Increased urinary calcium excretion
  - Men: > 7.5 mmols/day
  - Women > 6.2 mmols/day
  - May or may not be due to hypercalcemia

Pathogenesis- 20%
Hyperuricosuric calcium nephrolithiasis

- **20%** of calcium oxalate stones are associated with
- increased uric acid secretion (*hyperuricosuric calcium nephrolithiasis*), with or without hypercalciuria.
- The mechanism of stone formation in this setting involves
- "nucleation" of calcium oxalate

by uric acid crystals in the collecting ducts.

5%
Pathogenesis - HYPEROXALURIA

- **5%** are associated with *hyperoxaluria*, either **HEREDITARY** (primary oxaluria)

or, more commonly,

ACQUIRED by intestinal overabsorption in patients with enteric diseases.

Enteric hyperoxaluria, also occurs in vegetarians, because much of their diet is rich in oxalates.

Calcium salt stones

- Hyperoxaluria:
  - Causes the formation of calcium oxalates without hypercalciuria
  - Diet rich in oxalates
  - Increased oxalate absorption in fat malabsorption
- Primary hyperoxaluria:
  - Due to inborn errors
  - Urinary oxalate excretion: > 400 mmols/day

Pathogenesis
Idiopathic calcium stone disease

- *In a variable proportion of individuals with calcium stones,* **no cause** can be found

(idiopathic calcium stone disease).

Pathogenesis- HYPOCITRATURIA

- *Hypocitraturia*, associated with acidosis and chronic diarrhea of unknown cause, may produce calcium stones.
-

Calcium oxalate stones

Pathogenesis

Magnesium ammonium phosphate stones

- Formed largely after infections by bacteria (e.g., *Proteus* and some staphylococci) that convert urea to ammonia.
- The resultant alkaline urine causes the precipitation of magnesium ammonium phosphate salts.

Pathogenesis

Magnesium ammonium phosphate stones

- These form some of the **largest stones**,
- as the amounts of **urea** excreted normally are huge.
- Indeed, so-called ***staghorn calculi*** occupying large portions of the renal pelvis are almost always a consequence of **infection.**

Pathogenesis- URIC ACID stones

- *Uric acid stones* are common in individuals with hyperuricemia, such as gout, and diseases involving rapid cell turnover, such as the leukemias.

However, *more than half of all patients with uric acid calculi have neither hyperuricemia nor increased urinary excretion of uric acid*.

- In this group, it is thought that an unexplained tendency to excrete urine of pH below 5.5 may predispose to uric acid stones, because uric acid is insoluble in acidic urine. In contrast to the radiopaque calcium stones, uric acid stones are **radiolucent**.

Pathogenesis- CYSTINE STONES

- ***Cystine stones*** are caused by
- ***genetic defects*** in the renal reabsorption of amino acids, including ***cystine***, leading to ***cystinuria***.
- Stones form **at** ***low urinary pH***.

Pathogenesis

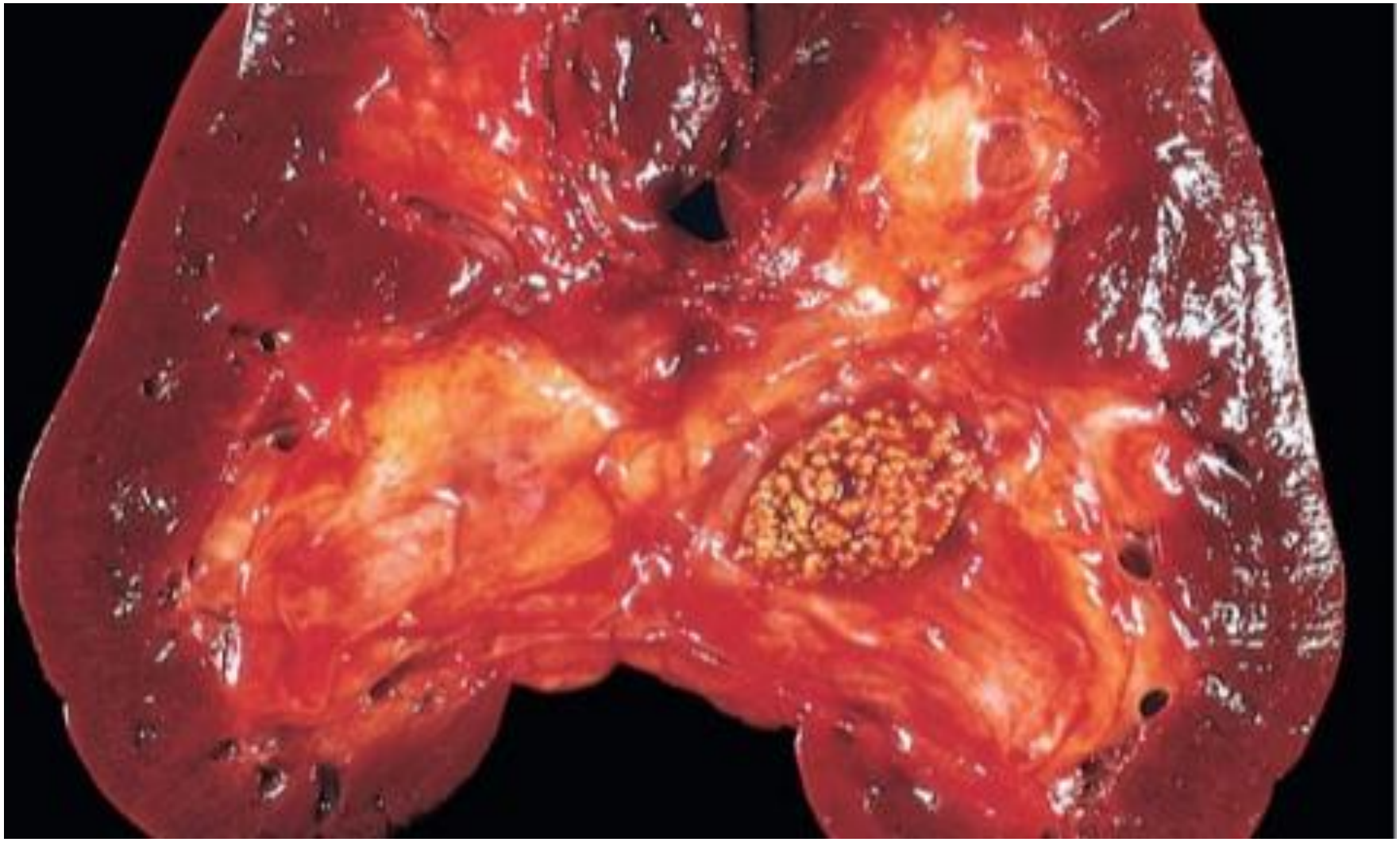
- It can therefore be appreciated that

1. increased concentration of stone constituents,
2. changes in urinary pH,
3. decreased urine volume, and
4. the presence of bacteria

influence the formation of calculi.

Morphology

- Often **many stones** are found within one kidney.
- On occasion, progressive accretion of salts leads to the development of **branching structures known as staghorn calculi,** which create a **cast** of the pelvic and calyceal system.



Clinical Features

- Severe abdominal or flank pain
- Frequency and dysuria
- Oliguria and anuria in obstruction
- Hematuria
- Renal colic
- Nausea
- hydronephrosis

Smaller Stones

- In general, **smaller stones are most hazardous,**
- because they may pass into the ureters, producing **colic**, one of the most intense forms of **pain**, and
- ureteral **obstruction**.

If stones grow to sufficient size (usually at least 3 millimeters (0.12 in)) they can cause obstruction of the ureter.

- **Ureteral obstruction** causes
- **Postrenal azotemia** and
- **Hydronephrosis** (distension and dilation of the renal pelvis and calyces), as well as
- **Spasm of the ureter.**

Ureteral Obstruction leads to pain, most commonly felt in the flank, lower abdomen, and groin (a condition called **renal colic**).

- **Renal colic can be associated with nausea, vomiting, fever, blood in the urine, pus in the urine, and painful urination.**

Renal colic typically comes in waves lasting 20 to 60 minutes, beginning in the flank or lower back and often radiating to the groin or genitals (The **Hallmark** of obstructive ureteral stones).

Larger Stones

- Larger stones cannot enter the ureters and are more likely to remain silent within the renal pelvis.
- Commonly, these larger stones first manifest themselves by **hematuria**.

Clinical features cont...

- Stones also predispose to superimposed infection, both by their obstructive nature and by the trauma they produce.

Diagnosis

HISTORY
PHYSICAL EXAMINATION

- Blood Analysis
- Urine Analysis
- CT Scan
- Abdominal x-ray
- Ultrasound
- Cystoscopy

Calcium salt stones

- Treatment:
  - Treatment of primary causes such as infection, hypercalcemia, hyperoxaluria
  - Oxalate-restricted diet
  - Increased fluid intake
  - Acidification of urine (by dietary changes)
    - Calcium salt stones are formed in alkaline urine

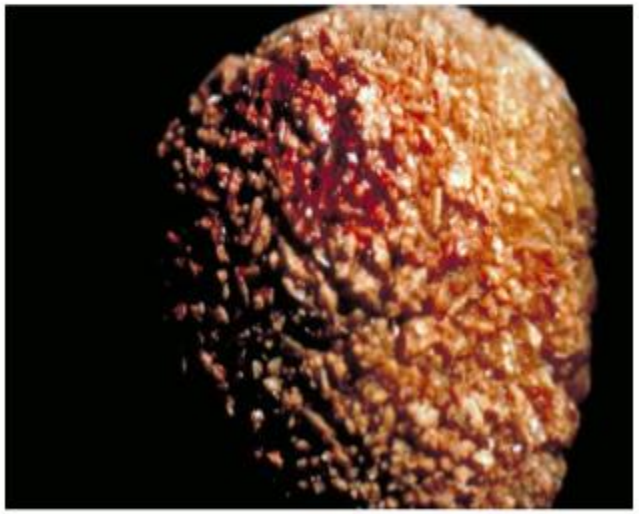
Uric acid stones

- About 8% of renal stones contain uric acid
- May be associated with hyperuricemia (with or without gout)
- Form in acidic urine
- General appearance:
  - Small, friable, yellowish
  - May form staghorn
  - Radiolucent (plain x-rays cannot detect)
  - Visualized by ultrasound or i.v. pyelogram

Uric acid stones

- Treatment:
  - Purine-restricted diet
  - Alkalinization of urine (by dietary changes)
  - Increased fluid intake

Uric acid stones



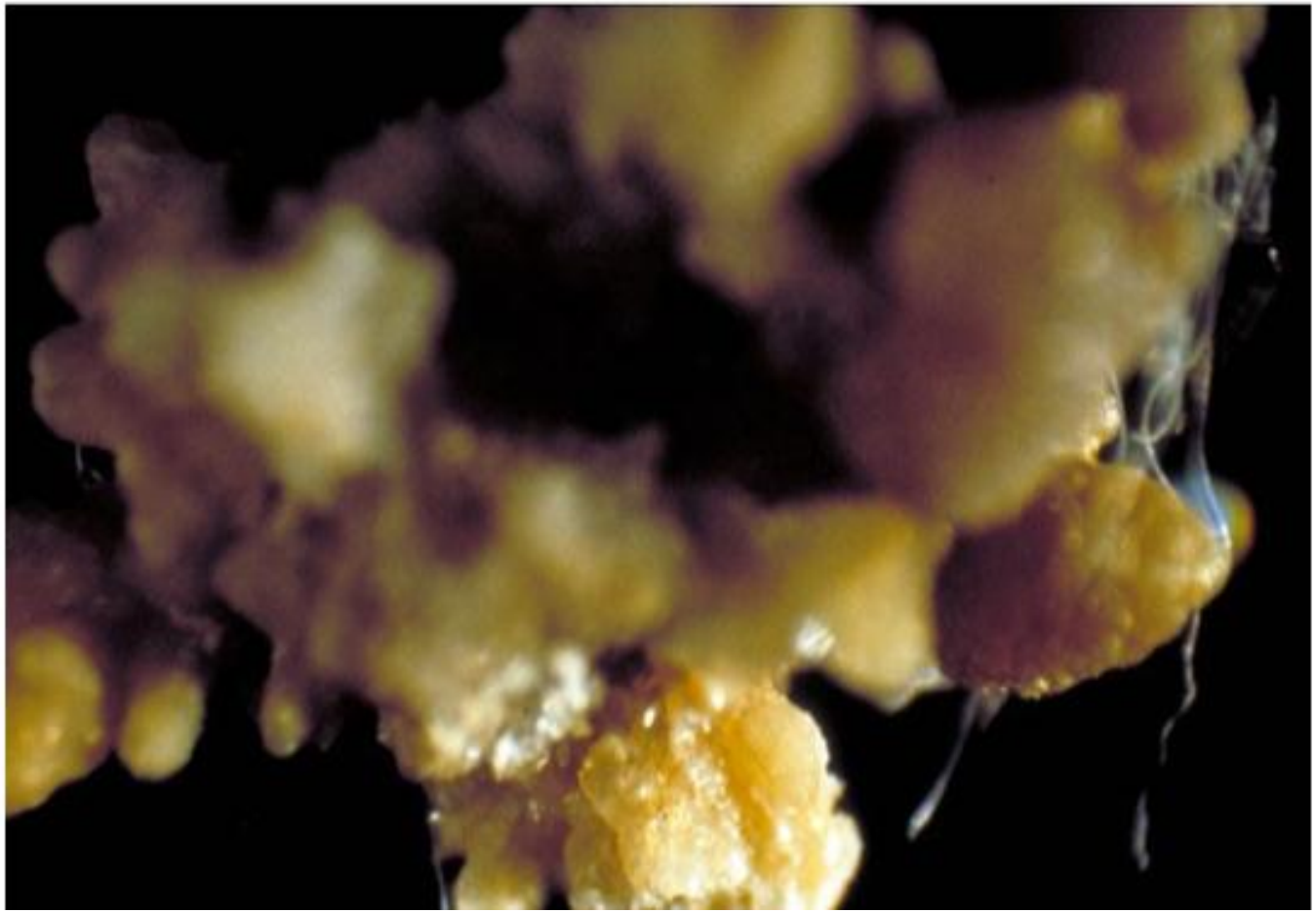
Cystine stones

- A rare type of kidney stone
- Due to homozygous cystinuria
- Form in acidic urine
- Soluble in alkaline urine
- Faint radio-opaque

Treatment:

- Increased fluid intake
- Alkalinization of urine (by dietary changes)
- Penicillamine (binds to cysteine to form a compound more soluble than cystine)

Cystine stone



Kidney Stones

Radioopaque

- Calcium Salt Stones
- Cystine stones (Faint)
- Struvite

Radiolucent

- Uric Acid Stones