

# Stone disease

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# Definition

- Presence of a solid, crystal material anywhere from the nephrons to the distal urinary tract
- (Nephrolithiasis, ureterolithiasis, cystolithiasis, urethrolithiasis)

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# Epidemiology



- The lifetime risk of renal calculi is approximately 12%.
- Male : Female is 3:1; due to discrete metabolic/ hormonal influences.
- The peak age of stone-related clinical episode in men is in the third decade. In women the peak incidence is in post- menopausal years.
- The incidence also varies in different populations.





# Risk Factors

- A prior history of nephrolithiasis
- Family history of stones
- Stone disease is more common in individuals with diabetes, obesity, gout, and hypertension
- Low fluid intake and diet
- Malabsorption (gastric bypass, short bowel syndrome)
- Frequent upper urinary tract infections
- Use of medications that crystalize in urine (acyclovir, triamterene)
- Bowel resection
- Gout
- Hyperparathyroidism

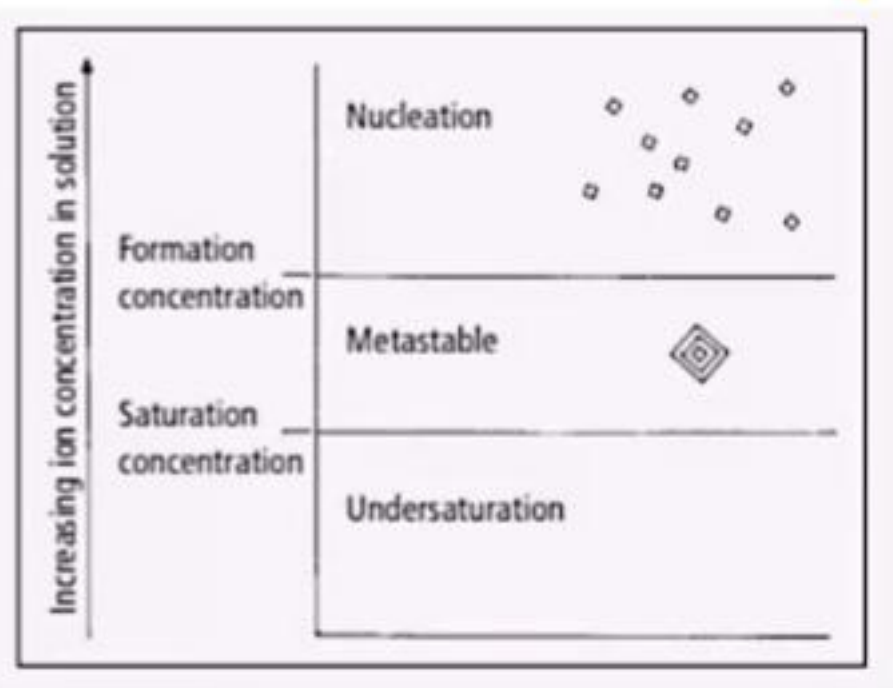


# Pathophysiology



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- Supersaturation
- Crystallization
- Growth



# Classification



- Calcium Stones
- Oxalate Stones
- Uric Acid Stones
- Cystine Stones
- Struvite Stones



# Calcium Stones

- Absorptive hypercalciuria
- Renal hypercalciuria
- Resorptive hypercalciuria



# Calcium Stones



- **Calcium Oxalate**
  - Incidence- 80% MOST COMMON
  - Acidic urine
  - Color: Black/brown
  - Radio-opaque
- **Calcium phosphate**
  - Incidence - 5-10%
  - Alkaline urine (esp when Proteus present)
  - Color dirty white
  - Radio opaque
  - RTA predisposes to Ca phosphate stones





# Oxalate Stones



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- Is the most common type of urinary tract stones.
- -It may be due to :
  - Hepatic Oxaluria
  - Rare, autosomal recessive disorder of metabolism
  - Enteric Oxaluria
  - Most common, chronic diarrhea and fat malabsorption
  - Dietary Oxaluria

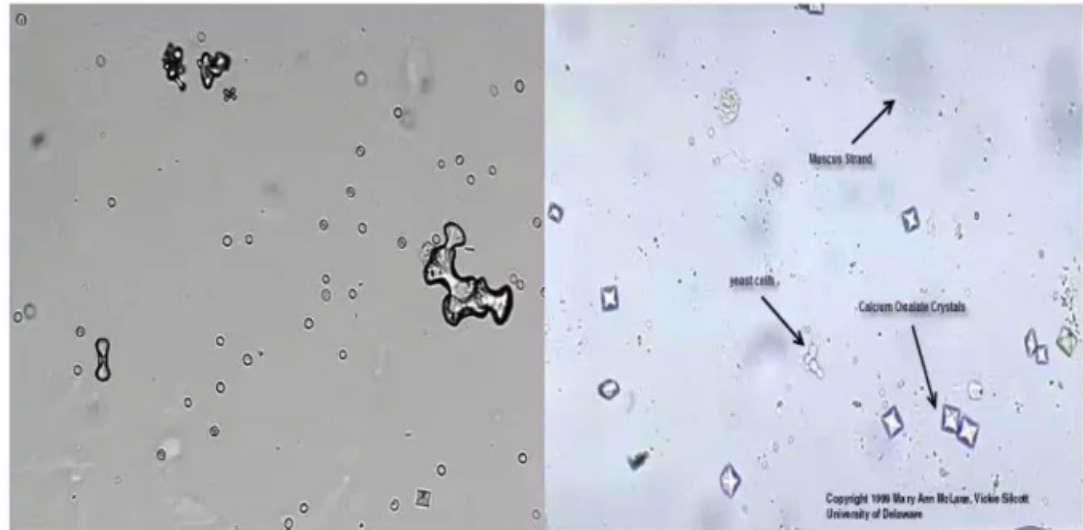


# Calcium oxalate crystals



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- Biconcave dumbbells or bipyramidal envelopes
- Develop in acidic urine.



# Uric Acid Stones



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- Prevalence: 6%
- Low urine pH (Urine Ph is less than 5.5)
- Metabolic syndrome, insulin resistance and diet rich in animal protein
- Hyperuricemia
  - Increased tissue breakdown and protein catabolism in association with chemotherapy for certain malignancies
- Pure uric acid stones are radiolucent. Commonly, they act as a nidus for calcium oxalate and calcium phosphate precipitation in which they become radio-opaque.



- Rhomboid shape



# Cystine Stones



- Prevalence: 1-2%
- In the setting of acidic urine
- Cystinuria
  - Autosomal recessive disorder characterized by defective intestinal or renal tubular transport of dibasic amino acids (COAL- cystine, ornithine, arginine, lysine)
- Most frequent cause of stones in children



# Struvite Stones



- Recurrent urinary tract infection
  - Elderly, women, diabetics, urinary tract abnormalities and spinal cord injury.
- Magnesium ammonium phosphate
- Urine pH > 7
- Urease producing bacteria (proteus, pseudomonas, staphylococcus)
- Urease hydrolyses urinary urea into ammonium with resultant alkalinisation of urine
- May cause **staghorn stone** if left untreated



- rectangular prisms (coffin lid-appearance)





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Types	Incidence	Etiology/associated findings	Urine pH	Crystal appearance	Radiopacity	Prophylaxis
Calcium oxalate stones	• ~ 75%	<ul style="list-style-type: none"> <li>• Hypercalciuria</li> <li>• Hyperoxaluria</li> <li>• Hypocitraturia</li> <li>• Can result from increased intake of               <ul style="list-style-type: none"> <li>◦ Ethylene glycol (antifreeze)</li> <li>◦ Vitamin C</li> </ul> </li> <li>• Associated with inflammatory bowel disease, i.e., ulcerative colitis and Crohn disease due to malabsorption</li> </ul>	<ul style="list-style-type: none"> <li>• ↓ Urine pH (acidic)</li> </ul>	<ul style="list-style-type: none"> <li>• Biconcave dumbbells or bipyramidal envelopes </li> </ul>	<ul style="list-style-type: none"> <li>• Radiopaque</li> </ul>	<ul style="list-style-type: none"> <li>• Urine alkalization</li> </ul>
Uric acid stones	• ~ 10%	<ul style="list-style-type: none"> <li>• Gout, hyperuricemia, and hyperuricosuria</li> <li>• High cell turnover (e.g., leukemia, chemotherapy)</li> </ul>	<ul style="list-style-type: none"> <li>• ↓ Urine pH (acidic) and volume (often seen in desert climates)</li> </ul>	<ul style="list-style-type: none"> <li>• Rounded rhomboids, rosettes, or needle-shaped </li> </ul>	<ul style="list-style-type: none"> <li>• Radiolucent</li> </ul>	<ul style="list-style-type: none"> <li>• Urine alkalization</li> </ul>
Struvite stones	• ~ 5-10%	<ul style="list-style-type: none"> <li>• UTI with urease-producing bacteria (e.g., <i>Proteus mirabilis</i>, <i>S. saprophyticus</i>, <i>Klebsiella</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• ↑ Urine pH (alkalic)</li> </ul>	<ul style="list-style-type: none"> <li>• Rectangular prisms (coffin lid-appearance) </li> </ul>	<ul style="list-style-type: none"> <li>• Weakly radiopaque</li> </ul>	<ul style="list-style-type: none"> <li>• Urine acidification</li> </ul>
Calcium phosphate stones	• < 5%	<ul style="list-style-type: none"> <li>• Hyperparathyroidism</li> <li>• Type 1 renal tubular acidosis</li> </ul>	<ul style="list-style-type: none"> <li>• ↑ Urine pH (alkalic)</li> </ul>	<ul style="list-style-type: none"> <li>• Wedge-shaped prisms </li> </ul>	<ul style="list-style-type: none"> <li>• Radiopaque</li> </ul>	<ul style="list-style-type: none"> <li>• Urine acidification</li> </ul>
Cystine stones		<ul style="list-style-type: none"> <li>• Cystinuria (hereditary)</li> </ul>	<ul style="list-style-type: none"> <li>• ↓ Urine pH (acidic)</li> </ul>	<ul style="list-style-type: none"> <li>• Hexagon-shaped </li> </ul>	<ul style="list-style-type: none"> <li>• Weakly radiopaque</li> </ul>	<ul style="list-style-type: none"> <li>• Urine alkalization</li> </ul>
Xanthine stones		<ul style="list-style-type: none"> <li>• Xanthinuria (hereditary)</li> </ul>	<ul style="list-style-type: none"> <li>• Generally independent of urine pH</li> </ul>	<ul style="list-style-type: none"> <li>• Amorphous</li> </ul>	<ul style="list-style-type: none"> <li>• Radiolucent</li> </ul>	<ul style="list-style-type: none"> <li>• N/A</li> </ul>





# History



- **Symptoms:** pain, hematuria, N/V
- **Past medical & surgical history:** stones, UTI, gout, hyperparathyroidism ...
- **Family history**
- **Drug history:** chemotherapy, Ca<sup>++</sup>, diuretics ...
- **Social history:** fluid intake, diet



# Kidney Stones



- Asymptomatic
- Flank pain, non radiating
- Hematuria (microscopic or occasionally macroscopic)
- Recurrent UTI
- Malaise, weakness, loss of appetite, N/V



# Ureteral Stones



- Sudden onset of severe colicky flank pain
- Pain radiates to groin, testicles or labia majora
- Hematuria (microscopic or gross)
- N/V, pallor, sweating



# Bladder Stone



- Consist of struvite or uric acid
- They occur in males over 50 that have a voiding defect due to bladder obstruction also occur in chronic cath patients.
- Asymptomatic (and incidentally found on KUB X-ray, bladder ultrasound or cystoscopy)
- Suprapubic or perineal pain
- Hematuria
- Urgency
- Recurrent UTI
- Poor flow
- Hesitancy



# Investigation



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- Urine analysis and culture
- Metabolic workup (calcium, uric acid, creatinine, urea)
- Any stone should be analyzed by x-ray crystallography.
- CBC
- KFT





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- **KUBx-ray:**(initial imaging for follow up and to know if its radiolucent or opaque)
  - **Radio-opaque:** calcium containing(Ca oxalate, Ca phosphate)
  - **Relatively Radiolucent (radiofaint):**struvite and cysteine
  - **Completely radiolucent:** uric acid



This is a K. U. B x Ray showing stone at the middle of the left ureter



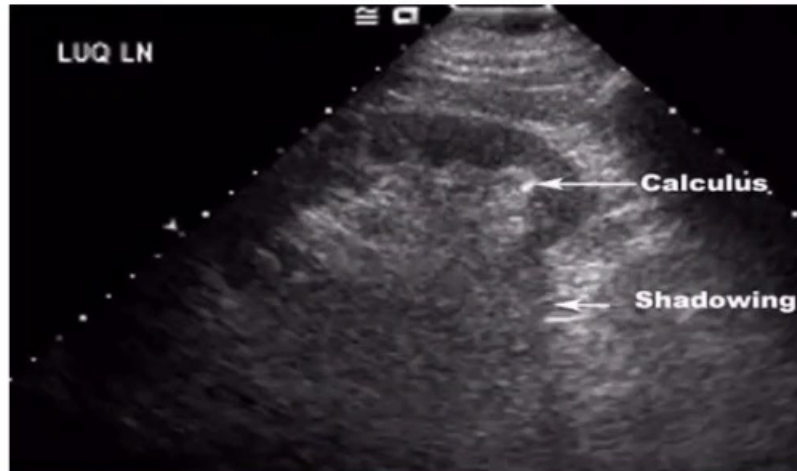
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# Imaging Studies

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- **Ultrasound:** (hydronephrosis, misses 30% of stones )
- Stones appear only in kidney,
- Stones do not appear if they are in ureter





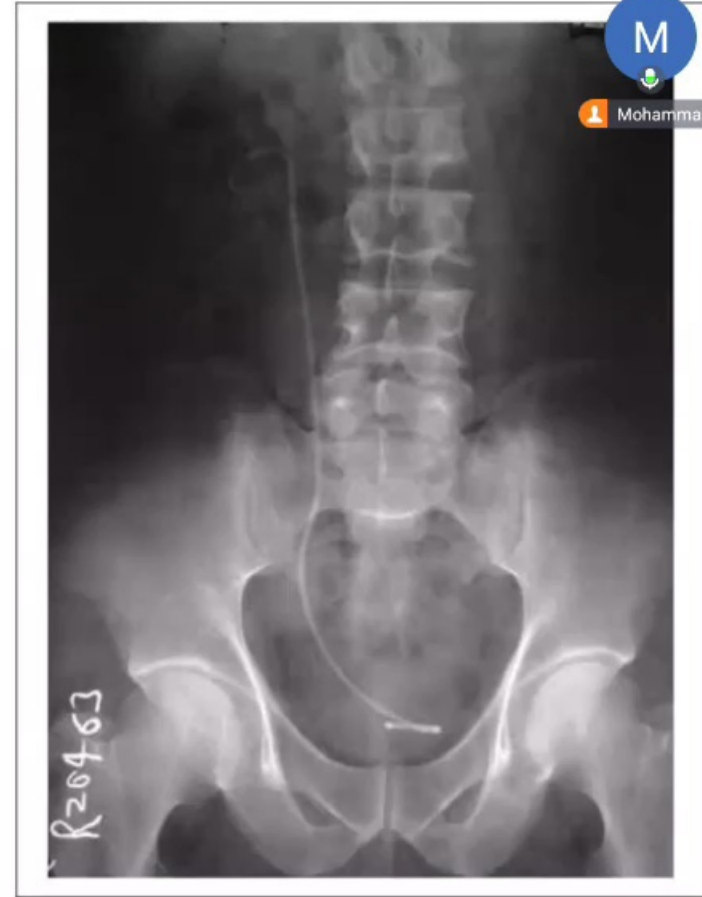
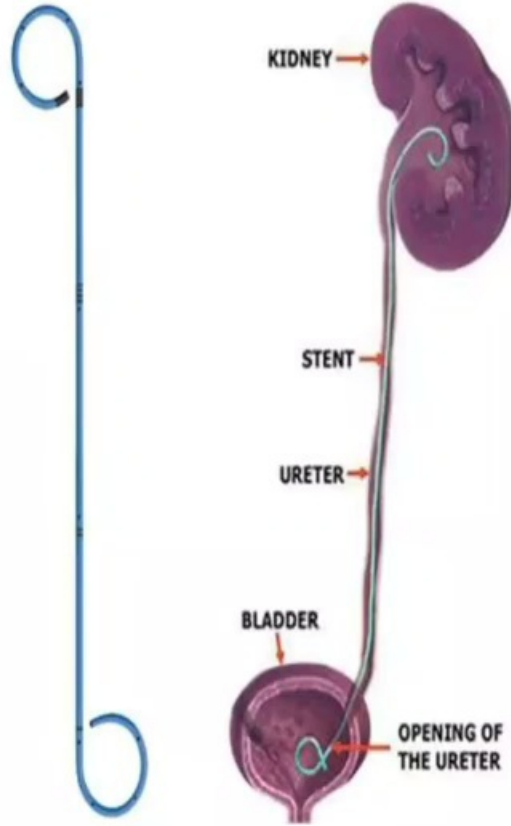
# Imaging Studies

- **Non contrast enhanced CT scan:** gold standard for diagnosis



# Management

- Analgesia
- IV fluid
- Double J-stent placement



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# Management



- Indications of DJ stent insertion
- Medical Expulsion Therapy (Analgesics, Alpha blocker, CCB)



# Management



- Depends on the size and site of stone
- ESWL
- Ureteroscopy and laser treatment
- PCNL
- Open surgery



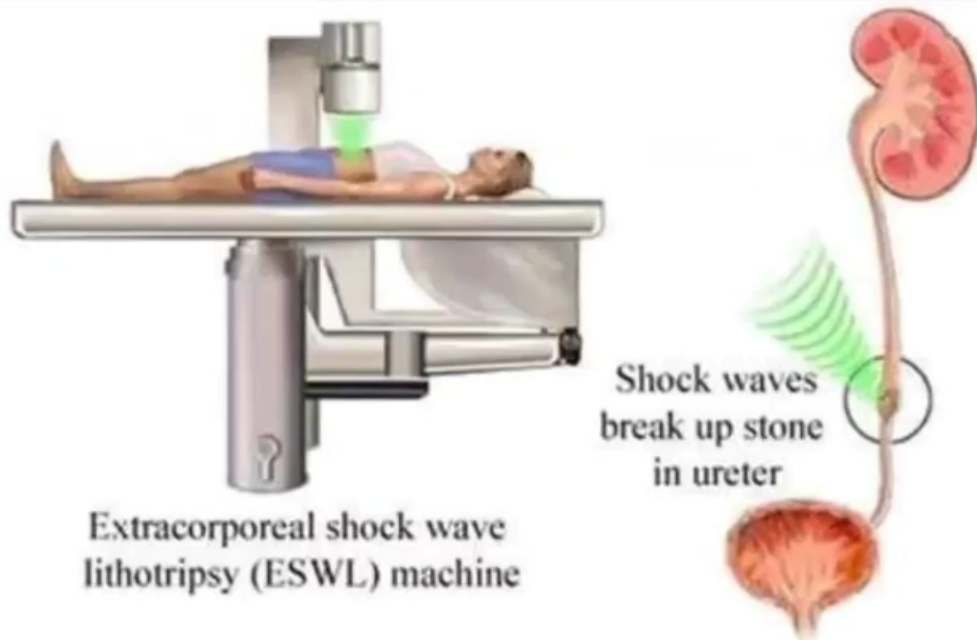
# ESWL



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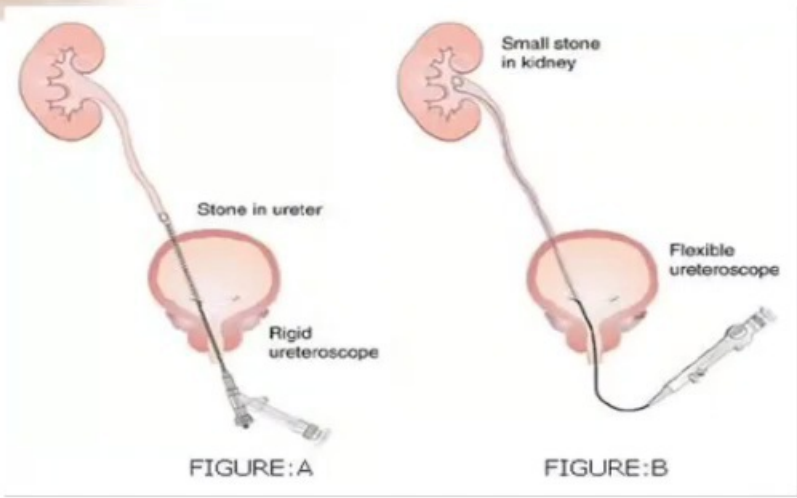
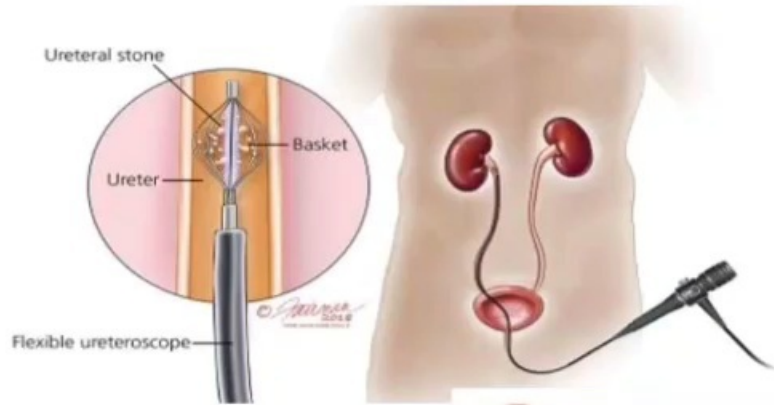
- Extracorporeal shock wave lithotripsy
- The efficacy of ESWL depends on stone size, location, anatomy of renal collecting system, degree of obesity and stone composition.

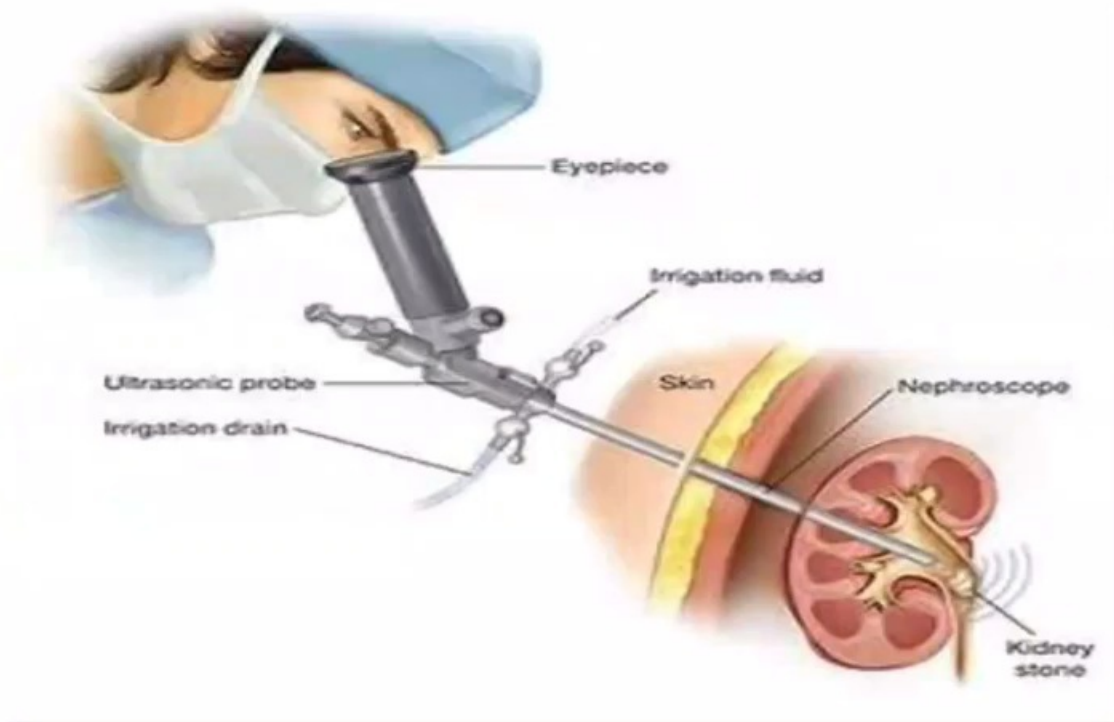




Extracorporeal shock wave lithotripsy (ESWL) machine









# PCNL



- Percutaneous Nephrolithotomy
- PCNL is the removal of a kidney stone via a track between the surface of the skin and the collecting system of the kidney.
- PCNL gives the best chance of stone clearance with a single procedure but this is achieved at a higher risk of morbidity.
- **Indications:** 1st line option for staghorn calculi >2cm or failed ESWL and flexible ureteroscopy
- **Contraindications:** UTI and bleeding tendency



# Open Surgery



- **Laparoscopic or open stone removal (Pyelolithotomy/ureterolithotomy):**
- Indications:
  - complex stone burden: projection of stone into multiple calyces
    - Failure of endoscopic treatment
  - Difficulty performing endoscopic treatment due to anatomic renal abnormality, obesity, kyphoscoliosis
  - Nonfunctioning kidney





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*50% of patients may have a new episode of nephrolithiasis within 10 years*

