Disclosures

• Successful completion: Participants must attend the entire program, including any resulting Q & A.
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Use of Radiologic Imaging in the Management of Urolithiasis

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Upon completion of this presentation, participants will be able to:

1. Have a clinical understanding of kidney stones and their impact on patients.

2. Recognize urologic anatomy seen on radiographs used to diagnosis renal stones.

3. Describe treatment options for renal stones and the role radiology plays.
What are Kidney Stones?

Anatomy

THE URINARY TRACT

Anatomy

Ureteropelvic junction
Iliac crest
Ureterovesical junction
Kidneys in Relation to Bony Anatomy

Variations in Anatomy

Clinical Symptoms

- Pain
- Nausea/Vomiting
- Hematuria
- Fevers if infection is present
History of Stones

- Kidney stones found in 5000 year old Egyptian mummy by archeologists in the early 1900’s

- Treatments for stones were mentioned in ancient Egyptian medical writings from 1500 B.C.

Historical Perspective

- In the Middle Ages, surgeons in Europe called "lithotomists"
- Traveled around with "lithotomy tables to perform removal of bladder stones"
- No anesthesia or antibiotics led to high complications and mortality rates

Historical Perspective

- Dutch blacksmith named Jan de Doot who had his portrait painted in 1651 with a stone he removed from his own perineum with a kitchen knife
Diagnostic Tests

1) X-Rays (Plain film KUB, live fluoroscopy)
   - most stones are radio-opaque
   - Uric acid stones are NOT visible

2) Computed Tomography
   - Detailed, quick study
   - Shows size, location and anatomy
   - Radiation exposure

3) Ultrasound
   - Detect stones, hydronephrosis due to blockage
   - Assess ureteral jet's in the bladder

4) Intravenous Pyelogram (IVP).
   - Not done anymore

X-Rays

- KUB (Kidney, Ureter, Bladder)

Renal Ultrasound

- Calculus
- Shadowing
Treatment Modalities for Urolithiasis

- Medical Expulsion Therapy
- Extracorporeal Shockwave Lithotripsy (ESWL)
- Ureteroscopy with laser lithotripsy
- Percutaneous Nephrolithotomy (PCNL)
- Open surgery

Medical Expulsion Therapy

- 5mm or smaller stones
- Distal stones
- Alpha-blockers (Tamsulosin) relaxes muscles of the ureter
- Pain control (NSAIDS, pain killers)
- Allow 3-6 weeks for stone to pass
- Role of Radiology: Follow-up imaging to assess stone has passed and check for resolution of hydronephrosis.

Relief
Extracorporeal Shockwave Lithotripsy (ESWL)

- Easier to perform on visible stones on plain x-ray
- Non radio-opaque stones require special technique
- Works well on less dense stones
- Works on stones in the kidney or ureter
- Less effective in obese patients because of poor visualization due to increased body tissue
Radiologic role for ESWL

Fluoroscopy is crucial for ESWL

Ureteral Stents

- Relieves obstruction by stone
- Temporary until definitive treatment
- Allows for passive dilation of ureter
- Placement requires fluoroscopy
Ureteral Drainage – Overview

A ureter may become obstructed as a result of a number of conditions including kidney stones, tumors, blood clots, postsurgical swelling, or infection.

A ureteral stent is placed in the ureter to restore the flow of urine to the bladder.

A ureteral stent is a thin, flexible tube threaded into the ureter to help urine drain from the kidney to the bladder or to an external collection system.

The stent may remain in place on a short-term (days to weeks) or long-term (weeks to months) basis.

Ureteroscopy (URS) with Laser Lithotripsy

- No Incisions
- Scopes and instruments are done through natural openings
- Stones are broken up with Holmium laser
- Larger fragments can be removed with small baskets
- Higher success rates at clearing out stones than ESWL
- Not good for very large stones
**Ureteroscopic Access**

<table>
<thead>
<tr>
<th>Rigid/Semirigid Ureteroscope</th>
<th>Flexible Ureteroscope</th>
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<tbody>
<tr>
<td>• Common Sizes</td>
<td>• Common Sizes</td>
</tr>
<tr>
<td>- Standard 7.0–10 Fr</td>
<td>- 7.5–10 Fr</td>
</tr>
<tr>
<td>- Mini 4.8–6.5 Fr</td>
<td>- 7.0–10 Fr</td>
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<tr>
<td>• Applications</td>
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<tr>
<td>- Distal ureter</td>
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<td>- Mid-ureter</td>
<td>- Proximal ureter</td>
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<td>- Renal pelvis</td>
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**Step 1: Place guidewire**

- Place guidewire through cystoscope to the ureteral orifice
  - Utilize fluoroscopic control
- Advance guidewire up ureter into renal pelvis
- Difficulty encountered
  - Utilize ureteral catheter in combination with wire to gain access
- Place second guidewire

**Advancing the Flexible Ureteroscope**

- Backload the guidewire
- Straighten scope
- Hold guidewire firmly
- Support scope
Advancing the Flexible Ureteroscope

Access to Ureteral Orifice

Placing a Second Guidewire

- **Working Wire**
  - The wire on which all manipulations are performed during a procedure
    - Catheter passage
    - Dilator advancement
    - Balloon dilation
    - Stent placement

- **Safety Wire**
  - Redundant wire that establishes and maintains access to the urinary tract throughout the procedure

Ureteroscopic Access – Steps

1. Place guidewire
2. Advance ureteroscope
Ureteral Access Sheaths

- Access sheath dilates the ureter and assists in facilitating the passage of scopes and devices
- Provides a conduit for exchanging devices
- Protects tract tissue during multiple insertions and withdrawals

X-ray during Ureteroscopy
URS

- Allow removal of larger fragmented stones

Stone Retrieval Baskets

Nitinol Stone Retrieval Baskets

Percutaneous Nephrolithotomy (PCNL)

- Approach for very large renal stones
- Invasive, requires incision
- Risk of Blood Loss
- Painful
- Requires hospital stay
Percutaneous Nephrolithotomy (PCNL) Overview

- A preferred treatment for large stones within the kidney or upper ureter
- A tunnel is created from the skin into the kidney to allow passage of a nephroscope
- The nephroscope has an inner channel that allows passage of instruments that are used to locate the stone, perform intracorporeal lithotripsy to break up the stone, and retrieve the stone fragments
- Nephrostomy drainage is established

Opacify the Collecting System

Retrograde Injection of Contrast

- Assess renal anatomy
- Assess stone location
- Identify best route for access

Establish Percutaneous Access

Place Safety Guidewire

1) Advance 8/10 Fr dilator sheath over working wire
2) Remove 8 Fr dilator
3) Place safety wire through 10 Fr sheath; advance to bladder
Dilate the Tract

Balloon Dilatation

Step 1: Advance the balloon over the working wire

Percutaneous Balloon Dilatation Catheter

Step 2: Inflate the balloon

Balloon Dilatation
**Dilate the Tract**

**Balloon Dilatation**

1. Advance sheath over inflated balloon
2. Remove inflated balloon through sheath

**Step 3:**
Advance working sheath

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**Dilating the Tract**

**Rigid Dilators**

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**Dilate the Tract**

**Sequential Dilatation**

1. Sequentially advance dilators over 8 Fr guiding dilator in 2 Fr increments
2. Place working sheath
Remove Calculi

Perform Nephroscopy

- Remove working wire
- Rigid nephroscope
- Flexible nephroscope

Remove Calculi

Perform Lithotripsy

- Ultrasonic
- Laser
- Electrohydraulic
- Mechanical

Removing Calculi

Swiss LithoClast® Select System Lithotriptor

- Simultaneous ultrasonic & pneumatic lithotripsy
- Designed to improve efficiency of stone fragmentation
- Suction removes stone fragments
- Stone catcher captures stone fragments for pathology

Stone Catcher
Lithotripsy

Ultrasound Lithotripsy Procedure Steps in a PCNL

- Once the tract is dilated, stone fragmentation is performed by advancing the combined ultrasound and pneumatic probes through the Nephroscope and placing them directly on the stone.
- Stone fragments are then suctioned or basketed.

Bilateral staghorn calculus

Lithotripsy

Laser Lithotripsy Steps

- Laser Lithotripsy may be utilized as well.
- Size of Nephroscope can accommodate a much bigger caliber laser fiber.
- Stone fragments are then basketed, “dusted”, or left to pass through the urinary system.

Remove Calculi

Remove Stone Fragments

Baskets

Grasping forceps
Establish Nephrostomy Drainage

Nephrostomy Drainage Catheter

Position catheter

Drain in position

Case 1

• 27 yo male presents with severe left flank pain, nausea and vomiting x 2 days
• Laboratory tests show microscopic RBC in urine
• Radiology test
Case 1

- After IV pain medication and IV fluids are given, pain is controlled and patient opts for trial with medical expulsion therapy
- He is discharged with alpha blockers, NSAID and painkillers

Case 1

- Patient returns 4 days later with intractable pain
- He wishes to have something done now
- He's taken to the OR for a ureteral stent placement
- He is scheduled for an elective ureteroscopy with laser lithotripsy in a few weeks.