

Renal Stone Disease

What is a Stone?

- A Precipitation of secretions within an excretory organ
- Four sites: Renal, Prostatic, Biliary, Salivary
- Stone Formation needs Supersaturation of urine with solute in solvent
- Urine is acidic in morning, alkaline after meals, concentrated overnight
- Process of: Nucleation → Crystal Aggregation → Crystal Growth

Modifiers of Formation

- Inhibitors
 - Citrate - Complexing Ca to lower effective urinary [Ca]
- Complexors
 - Substances that form soluble complexes to decrease saturation
 - E.g. Magnesium, Oxalate, 'Functional' Terminal Ileum
- Promoters
 - Stimulate crystallization
 - E.g. Low urinary volumes, Dietary NaCl

Who Forms them?

- Typically:
 - Male > Female
 - Sedentary > Active
 - Low Fluid Intake
 - Abnormal Urinary Tract resulting in stasis
 - PUJO / Chronic Retention / Stricture disease
- Atypically:
 - Familial defects in Renal Function (E.g. Cystinuria)
 - Recurrent UTI's (E.g. Struvite M.A.P. Stones)
 - Foreign Body (E.g. The 'forgotten stent')

How do stones present?

- Symptoms
 - Renal Angle Colic
 - Visible Haematuria
 - Recurrent UTI / Pyelonephritis / Pyonephrosis
- Signs
 - Pyrexia
 - Tender Renal Angle
- 'Silent' Obstruction
 - Dilatation \neq Obstruction

Types of Stone

- **Non Calcium – Usually Radiolucent**
 - Infection Stones – 7% (Struvite or M.A.P.)
 - Uric Acid – 10%
 - Cystine – 1%
 - Xanthine
- **Calcium Containing**
 - Ca Oxalate – 60%
 - Pure
 - Mixed Brushite (PO_4^{3-}) / Apatite
 - Ca Phosphate – 20%

Imaging

- NC-CT modality of Choice with 'superiority' over IVU (EAU Guidelines 2012)
- Equivalence with other imaging in acute colic (Greenwell T et al)
- Dilated ≠ Obstructed (J Urol.1979 O'Reilly PH et al)

Treatment Strategy

- Maximise Spontaneous Stone Passage
- Intervene: stone progression; stone complications; low chance of passage
- Prevent further Urolithiasis
- Factors: Patient, Renal, Stone, Clinical
- Do all Stones need active treatment?
- Can any stones be ignored?
- Intracorporal vs Extracorporal?

Active Stone Treatment

- Pharmacotherapy for MET
 - SM mediators: Alpha-Blockers / Ca Channel Blockers
 - Analgesia: NSAID's / Limited Role for Opioids in acute colic setting (Holdgate A, Cochrane 2004)
- Extra-Corporeal Lithotripsy (ESWL)
 - Types: EM / PE / EM
- Intra-Corporeal Lithotripsy (RIRS & URS)
 - Access:
 - Retrograde Uretero-Renoscropy
 - Antegrade Nephroscopy / Uretero-Renoscropy
 - Energy:
 - Laser Lithotripsy / Electro-Mechanical / Ballistic

ESWL - Electrohydraulic

- High-voltage spark discharge causes explosive vaporization of water
- Water at the electrode tip is vapourised causing a gas bubble to rapidly expand
- Shockwave generated and reflected by metal plate

ESWL - Piezoelectric

- High-voltage pulse rapidly expands ceramic (barium titanate) elements that make up a spherical 'dish'
- Rapid expansion with electrical current causes shock wave generation

ESWL - Electromagnetic

- Two electrically conducting cylinder shaped plates
- Separated by an electrical insulator
- Electrical current passed through produces a strong magnetic field that results in rapid movement and generation of a shock

Intracorporal Lithotripsy

- Issues of: **Access & Energy**
- Rigid Ureteroscopy
 - UO, Pelvic brim, PUJ
 - Single, Double or No Wires
- Flexible Ureteroscopy
 - RIRS vs Antegrade approaches
 - Within access sheath
 - Difficult Ureteric Access due to end of scope
 - For ureteric navigation if failed access sheath passage

Intracorporal Lithotripsy

- Cystoscopic placement of Wires
- Always after retrograde pyelogram &
Always with XR C-arm
- Techniques: Safety, Dual Wire
- Material: Nitinol, Steel, PTFE Coated
- SENSOR (Boston Scientific) - Hydrophillic
Tip but extra mechanical strength
- TERUMO wire (RF)
- 'Standard' Wire (Cook)

Lasers

- Light Amplification by the Stimulated emission of Radiation
- Holmium : Yttrium AluminiumG
 - 2100nm wavelength – Invisible as outside visible spectrum
 - Only 0.4mm tissue penetration
- Greater SFR + Fragmentation with less perforation compared to mechanical ICL
- Safer, more effective, shorter operation time & postoperative recovery (Jeon **SS Int J Urol. 2005**)

Flexible Ureterorenoscopy

- Access Sheaths confer ureteric protection, lower intra-renal pressures, improve RIRS access (Auge B et al JEndour. 2004)
- Internal/External Diameter (Eg.11/13Fr)
- Allows access to all calyces
- Single 3Fr access channel allows laser fibre transit to stone or tumour
- Digital vs Optical

JJ Stents

- Introduced in 1970's (Finney RP 1978)
- JJ vs End-Flushing / French & Length
- Flexible polymers coated in Bismuth or Barium
- Nephrostomy vs Stenting
 - For urgent decompression of renal collecting systems, both equally effective (Pearle MS J Urol 1998)
- Stenting in relation to ESWL
 - No difference in Stone Free Rates between Stented & Non-Stented patients (El-Assmy J Urol 2006)
 - Decreased stone-free rates unless Ureteric Stone >2cm with obstruction

JJ Stents

- In Stone Disease

- Solitary Kidney, Sepsis, Obstruction, Symptom Relief, Impacted Stones, Post ESWL if >20mm

(EAU Guidelines 2011)

- Ureteric Injury

- Iatrogenic, Penetrating Traumatic

- Ureteric Stricture

- Routine stenting after URS for distal stones is unnecessary (Srivastava J Endourol 2003)

JJ Stents

- Stents **REDUCE** stone passage
 - Diminished peristalsis
 - Impaired stone passage (Lennon GM Eur Urol. 1997)
- Stents 'symptoms' in 80% of patients
 - Indwelling ureteral stents: evaluation of symptoms, quality of life and utility (Joshi HB et al J Urol. 2003).
- Alpha Blockers for Stent Symptoms
 - Relief of stent related symptoms: review of engineering and pharmacological solutions.
 - Alpha Blockers single most beneficial strategy for relief of stent symptoms (Dellis A et al J Urol. 2010)