Fragmentation of stones-
Selection of modality

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Overview

- Modalities of stone fragmentation
  - ESWL
  - Ballistic lithotripsy
  - Ultrasonic lithotripsy
  - Laser lithotripsy
  - Electrohydraulic lithotripsy

- Selection of modality
  - Upper ureteric calculi
  - Mid- and lower ureteric calculi

- Special circumstances
  - Steinstrasse
  - Impacted stone
  - Obesity
ESWL

- Principle that shockwaves are focusable
- 1983- distribution of Dornier HM3 electrohydraulic lithotriptor
- Currently 3\textsuperscript{rd} generation lithotriptors are available
  
  Storz Modulith SLX (electromagnetic)
Is Newer Always Better?

- Gerber R, Studer UE, Danuser H (J Urol 2005)
- Compared HM3 with SLX

Stone-free patients 1 day after ESWL with HM3, LSP and SLX, and re-treatment rate in each group
Ballistic/ Pneumatic lithotripsy

- Swiss Lithoclast®
Comparatively,

**Pros**
- Fragmentation rates of up to 93%
- Low risk of ureteral perforation (<1%)
- Relatively low cost and low maintenance

**Cons**
- High rate of stone propulsion of between 2% to 17% when treating ureteral stones
- Fragments <4 mm are associated with a higher rate of repeat ureteroscopy
- Bowing of the probe during lithotripsy appears to result in significant power loss
Ultrasonic lithotripsy
In Comparison,

**Pros**
- efficient combination of stone fragmentation and fragment removal
- fragmentation rates of up to 96.6%
- does not damage compliant tissue

**Cons**
- May overheat if insufficient irrigant is used
- higher suction pressures tend to draw air bubbles into the system, impeding vision
- bending the probe results in energy loss at the convexity of the bend, with the energy being transformed to heat
Clinical Efficacy of a Combination Pneumatic and Ultrasonic Lithotrite
**Holmium laser lithotripsy**

- **Light amplification by stimulated emission of radiation**

- A photothermal mechanism that causes stone vaporization

- Because tissues are composed mainly of water, the majority of the holmium laser energy is absorbed superficially, resulting in superficial cutting or ablating
Comparing,

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ flexible fibre</td>
<td>■ High cost</td>
</tr>
<tr>
<td>■ 95% fragmentation</td>
<td>■ Negligible risk of cyanide toxicity</td>
</tr>
<tr>
<td>■ reduced retropulsion</td>
<td></td>
</tr>
<tr>
<td>■ the zone of thermal injury associated with laser ablation is small (0.5 to 1.0 mm)</td>
<td></td>
</tr>
</tbody>
</table>
Electrohydraulic lithotripsy

- Works similar to ESWL
- Effective method, 90% fragmentation
- The major disadvantage of EHL is its narrow margin of safety owing to the risk of damage to ureteral mucosa and ureteral perforation
Ureteral calculi treatment

- AUA Ureteral Stones Clinical Guidelines Panel undertook a meta-analysis of all articles on ureteral calculi published over a 30-year period from 1966 to 1996

- The results were analyzed for ESWL in situ, ESWL after "push back," ESWL after stent insertion, PNL, ureteroscopy, and open stone surgery
Upper ureteric calculi

- ESWL, by whatever technique (push back or in situ), should be the primary approach for stones of less than 1 cm.
- ESWL, PNL, and ureteroscopy are all acceptable choices for stones >1 cm.
- Routine stent placement before ESWL was discouraged (no improvement in fragmentation).
Post 1996,

- Smaller flexible scopes with holmium laser gives a stone-free rate of 95%, with 1% perforation/stricture rate.
- Indications: failed ESWL, patients with a history of cystine stones, patients with distal obstruction, impacted stones, obese patients, patients with bleeding diathesis
- For larger stones, PNL is an option
Lower & Mid Ureteric Calculi

- ESWL & ureteroscopy have good success rates

<table>
<thead>
<tr>
<th>ESWL</th>
<th>Ureteroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient</td>
<td>Single session</td>
</tr>
<tr>
<td>No stents</td>
<td></td>
</tr>
<tr>
<td>81% stone free</td>
<td>94% stone free</td>
</tr>
<tr>
<td>27% retreatment</td>
<td>8% retreatment</td>
</tr>
</tbody>
</table>
ESWL vs URS for Distal Ureteric Calculi: A Prospective Randomized Study
Peschel R. (J Urol 1999)

TABLE 2. Results

<table>
<thead>
<tr>
<th>Stones less than 5 mm.:</th>
<th>Ureteroscopy</th>
<th>ESWL</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range mins. operating (mean)</td>
<td>12–25 (18.8)</td>
<td>50–75 (63)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Range mins. fluoroscopy (mean)</td>
<td>0.3–1.4 (0.8)</td>
<td>1.4–7 (5.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Range days stone-free (mean)</td>
<td>0–1 (0.2)</td>
<td>1–43 (10.8)</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Range days with stent (mean)</td>
<td>4–14 (7.2)</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>% Re-treatment rate</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stones greater than 5 mm.:</th>
<th>Ureteroscopy</th>
<th>ESWL</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range mins. operating (mean)</td>
<td>20–43 (28)</td>
<td>40–62 (52)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Range mins. fluoroscopy (mean)</td>
<td>0.4–2.2 (1.4)</td>
<td>1.3–3.8 (2.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Range days stone-free (mean)</td>
<td>0–8 (3.7)</td>
<td>1–43 (9.1)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Range days with stent (mean)</td>
<td>4–7 (5.3)</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>% Re-treatment rate</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

There were no complications (p = 0.5).
Treatment of mid- and lower ureteric calculi: extracorporeal shock-wave lithotripsy vs laser ureteroscopy. A comparison of costs, morbidity and effectiveness
Berkins et al (BJU 1998)

- Concluded ESWL best for stones <50mm\(^2\), rest managed by URS
- Outpatient URS most cost and time efficient for larger stones
Steinstrasse

- Steinstrasse is a well-known complication of ESWL
- Most cases resolving spontaneously
- When required, percutaneous nephrostomy alone has a success rate of >70%
- URS has an immediate success rate of 100%
- ESWL may be successful, but the results are less predictable than with ureteroscopy.
- PNL may be used as a salvage procedure, with open ureterolithotomy reserved for failure of less invasive modalities
Impacted stone

- Tend to be resistant to ESWL or requires auxiliary endoscopic procedure
- URS is the preferred option
- Holmium laser is used to vaporize the stone
Obesity

- ESWL is effective but requires modifications

- URS is effective but associated anaesthesia needs consideration
Thank you