Reducing Intra-Operative Fluoroscopy Time in Percutaneous Nephrolithotomy

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Introduction

• PCNL with fluoroscopic guidance is associated with highest amount of radiation of any endourological procedure

• Mean radiation dose
  – Patient: 7.3 mSv
  – Physician: 12.7 mSv
Introduction

- Internally our goal was to challenge ourselves to determine how low we could reduce radiation exposure during PCNL in a tertiary care academic medical center where residents and fellows are involved in procedures.
Methods

• We prospectively set the goal to actively reduce amount of radiation used during PCNL (surgeon guided access)
• We retrospectively collected data:
  – Group 1: Pre-dose reduction
  – Group 2: Post-dose reduction
• All consecutive cases to avoid selection bias
Methods

• Measures implemented to reduce radiation dose
  – Spot checking rather than continuous live fluoroscopy
  – Low-dose setting on GE 9900 OEC C-arm (50% reduction in millamperage and variable reduced KVP)
  – Pulsed-mode used extensively (4 fps)
  – Last image hold
  – Increased reliance on tactile feedback
  – Active communication with xray technologist
## Specific Examples

<table>
<thead>
<tr>
<th>Step</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial needle placement</td>
<td>Small segments of live fluoro used; imaging stopped as soon as needle thought to be in calyx</td>
</tr>
<tr>
<td>Wire Access</td>
<td>Spot images primarily used with small live segments if wire manipulation difficult</td>
</tr>
<tr>
<td>Balloon / Sheath Placement</td>
<td>Spot images only used with balloon inflation and sheath advancement</td>
</tr>
<tr>
<td>Flexible nephroscopy / Eval of calyces</td>
<td>Images used only if visualization difficult</td>
</tr>
<tr>
<td>Stent / NT Placement</td>
<td>Spot images only</td>
</tr>
</tbody>
</table>
Standard vs Low-Dose

Standard dose

Low dose
## Results

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Number</strong></td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td><strong>Median Age (range)</strong></td>
<td>55 (30 - 80)</td>
<td>32 (21 - 75)</td>
</tr>
<tr>
<td><strong>Median Stone burden (largest axial x coronal diameter)</strong></td>
<td>27.3 x 29.2 mm</td>
<td>29.4 x 33.6 mm</td>
</tr>
<tr>
<td><strong>Median BMI</strong></td>
<td>32 kg/m$^2$</td>
<td>30 kg/m$^2$</td>
</tr>
<tr>
<td><strong>Median/Mean Fluoroscopy Time (range)</strong></td>
<td>240/281 sec (56.0 - 916.0)</td>
<td>65.5/128 sec* (13.0 – 561.0)</td>
</tr>
<tr>
<td><strong>Stone Free Rate</strong></td>
<td>62.2%**</td>
<td>65.9%**</td>
</tr>
<tr>
<td><strong>Ancillary Procedures</strong></td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Complications (Clavien 3a+)</strong></td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

*p < 0.001

**Based on completely stone-free – ie. No residual fragments of any size.
Discussion

• Factors associated with increased radiation dose
  • ↑ BMI, stone burden, # of access tracts
  • Non-branched configuration
Monga: Endo-Guided Access Dose Reduction

- Compared a series of patients undergoing traditional fluoroscopic guidance vs endo-guided access
- Complication rates similar between the groups

Reduced fluoroscopy time from 16.8 minutes to 3.2 minutes

Baldwin: Reduced Fluoro Protocol

- Visual and tactile cues
- Fixed lowered mAs and kVp
- Laser guide on C-arm
- Designated fluoroscopy technician
- Surgeon foot pedal control
- Single pulse per second fluoroscopy
- 80.9% reduction in fluoroscopy time

Reduced fluoroscopy protocol for PCNL: Feasibility, outcomes, and effects on fluoroscopy time. Baldwin et al., J Urol, 2013

Reduced fluoroscopy time from 175.6 sec to 33.7 sec
Learning Curve for Ultrasound Access

- Fellowship trained surgeon expert in fluoroscopic access
- *Hands on hands* mentored by surgeon expert in ultrasound access
- Improvement noted by 20 cases but continued improvement over 100 cases
- Fluoroscopy time reduced from average of **157.5 sec to 33.4 sec**

Adopting ultrasound guidance for prone PCNL: Evaluating the learning curve for the experienced surgeon. Chi et al., J Endo, 2016
Adult Obesity Rate by State, 2015

Select years with the slider to see historical data. Hover over states for more information. Click a state to lock the selection. Click again to unlock.

Percent of obese adults (Body Mass Index of 30+)

- 0 - 9.9%
- 10 - 14.9%
- 15 - 19.9%
- 20 - 24.9%
- 25 - 29.9%
- 30 - 34.9%
- 35%+

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Adult obesity rates, 1990 to 2015

**Pennsylvania, 2015**

- Adult Obesity Rate: 30.0%
- State Rank: 24

95% Confidence Interval +/- 1.6%
BMI < 25 BMI 25-29.9 BMI > 30

Successful Ultrasound Guide Access

45.7%

Ultrasound Guidance to Assist PCNL..., Chi et al., J Urol, 2016
Conclusions

• Fluoroscopy time can be significantly reduced by adopting simple techniques and having active communication with xray technologist

• 72.7% reduction in median fluoroscopy time with current protocol

• Ultrasound guided access remains best choice for ultimate radiation dose reduction,
  • Both resident training in the U.S. and high BMI of patient population are challenges to widespread adoption