Computed Tomography-guided Interventional Procedures
AAPM 2019
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Disclosures

I ♥ AAPM – thank you for your commitment to Lung Cancer Screening!

Unrelated
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• Elsevier [royalties]
### Interventional Radiology - Scope of Practice
- Abdominal aortic aneurysms
- Abscess and other fluid drainage
- Angiography
- Angioplasty and stent placement
- Bilary obstruction
- Deep vein thrombosis
- Gastroscopy & other feeding tubes
- Gastrointestinal hemorrhage
- Hernia/surgical hernia: intestinal obstruction
- Hypertension and end-stage renal disease
- Infertility
- Liver disease/portal hypertension
- Lymphatic and venous disorders
- Mesenteric ischemia
- Nephrotic syndrome
- Pediatrics
- Psoriatic arthropathy
- Peripheral arterial disease
- Pulmonary embolism
- Stroke and carotid artery disease
- Trauma
- Tumor treatment
- Tuberous sclerosis
- Urinary tract obstruction
- Uterine fibroids
- Varicose veins
- Vascular malformations
- Venous access
- Vertebroplasty

### Tools
- CT
- Fluoroscopy
- Ultrasound
- MRI
- PET-CT

### Our Job
1. Localize target
2. Guide needle/probe/catheter to target
3. Avoid critical structures
4. Intervention

### Outcomes
- Technical success
- Patient safety
- Procedure time
- Radiation dose
<table>
<thead>
<tr>
<th></th>
<th>CT</th>
<th>Fluoroscopy</th>
<th>Ultrasound</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>XX</td>
<td>XX</td>
<td>XXX</td>
<td>X</td>
</tr>
<tr>
<td>Visualize structures &lt;1cm</td>
<td>XX</td>
<td>X</td>
<td>XXX</td>
<td>X(X)</td>
</tr>
<tr>
<td>Visualize deep structures</td>
<td>XXX</td>
<td>XX</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Continuous image guidance</td>
<td>X</td>
<td>XX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>3D image data</td>
<td>XXX</td>
<td>X</td>
<td>XX</td>
<td>XXX</td>
</tr>
<tr>
<td>Z axis coverage</td>
<td>XX</td>
<td>XXX</td>
<td>X</td>
<td>XX</td>
</tr>
<tr>
<td>Time resolution</td>
<td>X</td>
<td>XXX</td>
<td>XXX</td>
<td>XX</td>
</tr>
</tbody>
</table>

(X = least favorable)

CT-guided Lung Biopsy

Helical technique during intervention
Helical technique during intervention

"CT fluoroscopy" (≠ cone beam CT)

Intermittent fluoroscopic mode

- Compared to helical, 50% less complications during lung biopsy. However,
- ~200% + operator dose,
- ~300% + patient dose

Cave: Ambiguous terminology for radiologists and technologists

See Radiol. 21, 213–220 (2011)
Radiology 2019; 291:241–249

CT-guided Lung Biopsy
Quick-check CT fluoroscopy during intervention

Pros: Faster, track respiratory motion
Cons: Less “juice”, less Z-axis coverage, dose (and lead!) for operator

Scout Planning Intervention Post intervention Helical Helical

CT-guided Lung Biopsy

Griffis, T. et al. MGH. Reduced computed tomography-guided chest biopsy procedure time and radiation dose with an axial, pedal-controlled acquisition technique. JVIR 2021; 30: S165 [Publication pending]

Fintelmann / MGH
Helical vs. quick-check: Time

<table>
<thead>
<tr>
<th>Table time</th>
<th>Helical vs. quick-check</th>
<th>Time difference</th>
<th>Improvement</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2 (1.5–9.0) min</td>
<td>11% (5–17%) improvement</td>
<td>p = 0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puncture time</td>
<td>8.1 (4.8–11) min</td>
<td>23% (16–30%) improvement</td>
<td>p &lt; 0.001</td>
<td></td>
</tr>
</tbody>
</table>

Table time: 5.2 (1.5–9.0) min shorter, 11% (5–17%) improvement, p = 0.007

Puncture time: 8.1 (4.8–11) min shorter, 23% (16–30%) improvement, p < 0.001

Helical vs. quick-check: Radiation

| Lower patient radiation | 240 (140–330) mGy × cm lower, 42% (33–49%) dose reduction |
| Same number of acquisitions | p = 0.35 |
| No detectable dose to operator | Body and lens dosimeters, monthly reads |

Lower patient radiation: 240 (140–330) mGy × cm lower, 42% (33–49%) dose reduction, p = 0.35

The Future

- Navigational guidance
  - Image fusion (MRI, PET, US, CT)
  - Electronic needle visualization
  - Body global positioning system
- Ablation volume planning
- Robotic-guidance
- Artificial Intelligence for procedure planning
Thank you!

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