Protocol optimization and dose variability for CT-guided interventions

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Disclosures

None
Unique characteristics of interventional CT imaging

- Repetitive irradiation of an anatomic territory
- Intent of imaging varies during a case
- Loosely defined protocols
Structure of a CT-guided intervention

Localization
Guidance and Monitoring
Post-procedure evaluation
Procedural guidance
Post-procedure evaluation
Dose economy for CT localization

• Diagnostic imaging precedes intervention and should be available for reference at the time of intervention
  – *Opportunity: minimize extent of localization scans*
36/82 (44%) submitted CT biopsies 2009-2011 started with a complete scan of C, A or P.
Dose economy for procedural scans

• Imaging technique: adequate is often good enough
  – Opportunity: Use low tube currents, rapid gantry rotation times
310 mAs
952 mGy-cm
14 mSv

30 mAs
73 mGy-cm
1.1 mSv
Bone biopsy

- 60 mAs, CTDI 6 mGy
- 30 mAs, CTDI 3 mGy
- 25 mAs, CTDI 2.5 mGy
- 20 mAs, CTDI 2 mGy
**Helical:** 10 mA, 0.5 s, 1.375

<table>
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<tr>
<th>Series</th>
<th>Type</th>
<th>Scan Range (mm)</th>
<th>CTDIvol (mGy)</th>
<th>DLP (mGy·cm)</th>
<th>Phantom cm</th>
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<td>0.76</td>
<td>0.76</td>
<td>Body 32</td>
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</table>

**Total Exam DLP:** 12.27

SmartStep Accumulated Exposure time 00:00:06.4

**0.2 mSv**
Dose economy for completion scans

• Intent and clinical judgment dictate the image quality required for post-procedure scans
  (a) Detection of pneumothorax after lung biopsy
  (b) Detection of small perihepatic or perisplenic hemorrhage

*Opportunity: Low dose scans of limited extent, when clinically appropriate*
CT-Guided Intervention with Low Radiation Dose: Feasibility and Experience

OBJECTIVE. The purpose of this study was to evaluate the feasibility of performing CT-guided interventional procedures with a very low radiation dose.

MATERIALS AND METHODS. We performed 291 CT-guided interventional procedures using a low dose of radiation. The subjects were 165 men and 126 women 22–89 years old with a mean age of 65 years. CT fluoroscopy was not used. The procedures were 201 percutaneous biopsies and 90 percutaneous aspiration or drainage procedures. Before the procedure, images were obtained with standard mAs of 175–250 mAs. All subsequent CT was performed at a reduced mAs. Technical success of catheter placement and biopsy was calculated, and the results were compared with those of procedures performed over the previous 12 months with standard radiation doses. Patient weight, lesion size, and number of CT acquisitions needed to complete the procedure were recorded.

RESULTS. All but three aspiration or drainage procedures performed at 30 mAs were successful, for a success rate of 96.7%. The technical success rate of biopsy performed at 30 mAs was 93.5%. In the cases of 13 patients undergoing biopsy, the masses were not identified with low-dose technique, and these procedures were completed at a higher dose. Results were independent of patient weight and lesion size. The technical success rate was 98% for percutaneous drainage performed at a standard radiation dose in the 12 months before introduction of the low-dose technique. The technical success rate was 87.5% for biopsy performed at a standard radiation dose in the 12 months before introduction of the low-dose technique. The complication rate of the low-dose technique was comparable to that of the standard-dose technique.

CONCLUSION. Low-dose radiation technique using 30 mAs results in technical success for both catheter placement and percutaneous biopsy comparable to standard radiation dose.
MSKCC Lung Biopsy

Historical

Current practice

Non-contrast chest CT

Dose Length Product mGy cm

1282

6

210

Thornton R. Unpublished data.
CT guided thoracic biopsy


<table>
<thead>
<tr>
<th>Lowest dose/CT</th>
<th>Highest dose/CT</th>
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<tr>
<td>19 scans</td>
<td>14 scans</td>
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<tr>
<td>36 mA</td>
<td>770 mA</td>
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<td>116 mGy-cm</td>
<td>3170 mGy-cm</td>
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<td>&lt; 1 chest CT</td>
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NSD: weight, lesion size, depth, # procedural scans

2 mSv
54 mSv
3 academic centers

MSKCC  UNC-Chapel Hill  SUNY-Syracuse

370 procedures
10/15/2009-4/15/2010

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<tr>
<td>Abdomen</td>
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<tr>
<td>Pelvis</td>
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Results: DLP

Mean 35-fold variation (range 11-74 fold)
## Effective mAs

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<th>Pelvis</th>
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<td>Post scans</td>
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<td>55</td>
<td>183</td>
<td>&lt;0.0001</td>
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Components of variable dose

• Unique components
  – Patient body habitus
  – Procedure complexity
  – Equipment
  – Operator skill

• Manageable components
  – Selection of technical factors (CTDI)
  – Extent of pre- and post-intervention scans (length)
Tracking radiation doses related to interventional CT

- Awareness, practical guidance and education
- Benchmarks
  - Reference levels, ranges
  - Dose f(imaging work)
- Intra-procedural display of accumulating dose