Techniques to reduce radiation dose resulting from daily imaging guidance procedures

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2015 AAPM Annual Meeting SAM Session

Outline of talk

• An overview of radiation exposure to patients resulting from different image-guided procedures
• Available techniques to reduce imaging dose
• Methods of managing accounting for the imaging doses

Dose to patients: from MV portal imaging
3-5 cGy / pair of orthogonal MV setup fields

(Ding and Munro, Radiother Oncol, vol.108, 91-8, 2013)

Dose to patients: from MV-CBCT
2 -12 cGy depending on imaging procedures

Miften et al., Med Phys, 34, 3760-3767, 2007
Dose to patients: from MVCT

Tomo MVCT dose at the center of a 30 cm water phantom dependency on acquisition protocols

<table>
<thead>
<tr>
<th>MVCT in Tomo</th>
<th>dose (cGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition mode</td>
<td></td>
</tr>
<tr>
<td>Fine pitch (4mm couch travel/rotation)</td>
<td>2.5 cGy</td>
</tr>
<tr>
<td>Normal pitch (8mm couch travel/rotation)</td>
<td>1.2 cGy</td>
</tr>
<tr>
<td>Coarse pitch (12mm couch travel/rotation)</td>
<td>0.8 cGy</td>
</tr>
</tbody>
</table>

Courtesy of Edward Chao, Accuray Incorporated and T. Rock Mackie, UW, Madison, WI

Dose to patients: from kV radiograph

(Ding and Munro, Radiother Oncol, vol.108, 91-8, 2013)

Dose to patients: from kV-CBCT

OBI 1.3 vs 1.4
Dose differences in Head scan

(Ding et al., Radiother Oncol, vol.97, 585-592, 2010)
Dose to patients: from kV-CBCT

Techniques to reduce imaging dose

Which procedure has lowest dose?

20% 1. MV portal imaging...
20% 2. MVCT
20% 3. kV radiograph
20% 4. kV-CBCT...
20% 5. MV-CBCT
Techniques to reduce imaging dose

- Patient specific imaging dose calculations
  - Advantages:
    - Individual patient CT based image dose calculation
    - Accurate organ dose calculations from image procedures
  - Disadvantages:
    - Require patient CT based image dose calculation
    - Limitations of implementation in treatment planning system
      - Requires additional imaging beam configuration in a commercial treatment planning system
      - Inaccuracy of model-base dose calculations algorithm for kV beams
Summery

MV imaging:
- EPID: 3 - 5 cGy /pair of orthogonal portals
- MVCT (TOMO): 1 - 3 cGy
- MV-CBCT: 1 - 16 cGy

kV imaging:
- kV DR: 0.1 - 1.0 cGy /pair of orthogonal beams
- kV-CBCT
  - Soft tissue: 0.1 - 3 cGy /acquisition
  - Bone: 0.3 - 6 cGy /acquisition

Thank you!

Summery

Managing imaging guidance dose to patients
- Use x-ray imaging efficiently:
  - Choose the procedure and the frequency suitable for the purpose
  - Use available techniques to reduce dose to organs at risks
  - kV-imaging dose is much lower than MV imaging dose
- Document and account for imaging dose to organs
  - Patient specific imaging dose calculations,
  - Non-patient specific imaging dose estimations
- AAPM TG-180