Dosimetry for the Lens of the Eye, Applications for Medical Staff Involved in Interventional Radiology Procedures

Thérése GEBER, Mikael GUNNARSSON, Sören MATTSSON

Medical Radiation Physics

Department of Clinical Sciences Malmö, Lund University, Skåne University Hospital, Malmö, Sweden
Cataract

- Opacity of the lens of the eye
- Deterministic effect
- Threshold 0.5-2 Gy
- Dose limit 150 mSv/y
- Radiologists, Radiotherapy patients, A-bomb survivors, Chernobyl "liquidators", Astronauts…
- Far lower threshold or stochastic effect
- Present guidelines may underestimate the risk
Interventional Radiology

- Possibly high doses
  - High dose rates
  - Large workload
  - Extended fluoroscopy times
  - Close to patient
- Many personnel in the room
- Growing field
Aims

• Investigate the relation between the absorbed dose to the lens and the dose measured with a dosimeter at the forehead
• Investigate the relation between lens dose and dose to the patient
• Explore the dose distribution inside the head
• Examine the efficiency of eight models of protective eyewear
Methods

- Anthropomorphic head phantom, eye disc of polyethylene
- Thorax phantom for scatter
- TLD in phantom and headband, Radiochromic film
- Two senior physicians working with heavy fluoroscopy
- TLD in headband, same as in phantom measurements
- Measured during a variety of procedures
Results

**Phantom**

- Scatter dose vs. DAP (Gycm2)
  - Scatter dose (uSv) vs. DAP (Gycm2)
    - Right lens: $y = 5.4996x$, $R^2 = 0.9176$
    - Left lens: $y = 7.0069x$, $R^2 = 0.9721$

**Physicians**

- Scatter dose vs. DAP (Gycm2)
  - Scatter dose (uSv) vs. DAP (Gycm2)
    - Right lens: $y = 0.9987x$, $R^2 = 0.5771$
    - Left lens: $y = 0.6913x$, $R^2 = 0.5653$

**Absorbed dose (%)**

- Absorbed dose (%) vs. Position in headband (#)
  - Average Physician
  - Average Phantom

Lund University / Department of Clinical Sciences / Medical Radiation Physics / Therése Geber
## Results

<table>
<thead>
<tr>
<th>Left Lens/Headband over Left Eye (%)</th>
<th>125</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Lens/Headband over Right Eye (%)</td>
<td>125</td>
</tr>
</tbody>
</table>

Dose in the lens relative to the dose at the forehead, measured using TLDs
## Results

Remaining dose to the lens when using eyewear

<table>
<thead>
<tr>
<th>Eyewear (#)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Left TLD below (%)</td>
<td>72.4</td>
<td>43.0</td>
<td>77.5</td>
<td>84.8</td>
<td>86.1</td>
<td>22.4</td>
<td>35.1</td>
<td>69.7</td>
</tr>
<tr>
<td>Average Right TLD below (%)</td>
<td>98.2</td>
<td>89.1</td>
<td>96.8</td>
<td>93.8</td>
<td>96.6</td>
<td>89.2</td>
<td>87.6</td>
<td>92.0</td>
</tr>
<tr>
<td>Average Left TLD front (%)</td>
<td>17.8</td>
<td>14.4</td>
<td>27.1</td>
<td>26.0</td>
<td>22.5</td>
<td>14.3</td>
<td>15.5</td>
<td>20.0</td>
</tr>
<tr>
<td>Average Right TLD front (%)</td>
<td>17.0</td>
<td>13.0</td>
<td>24.7</td>
<td>26.1</td>
<td>23.7</td>
<td>17.1</td>
<td>18.9</td>
<td>16.6</td>
</tr>
</tbody>
</table>
Results

Without

Worst

Best

Above

White  6 mGy
Red    5 mGy
Orange 4 mGy
Yellow 3 mGy
Green  2 mGy
Cyan   1 mGy

Below
Conclusions

• Absorbed dose to the lens and DAP correlates well
  • Perhaps a factor for estimating the lens dose without measurements could be found
• Phantom measurements show that TLDs at the forehead underestimate the dose to the lens with 25 %
• There are deficiencies in the effect of protective eyewear when the incident radiation is not from the front
  • Could give a false sense of security
• The design of protective eyewear is decisive
  • Minimize gaps and mould around the face
  • Individual eyewear should be applied
Thank you for your attention!