Protection for occupational x-ray exposures especially in TIPS

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R. Adamus  R.Loose  M. Galster

Klinikum Nürnberg Nord
French Results for diagnostik reference values
flouroscopy times

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Reference Dose (Gy)</th>
<th>KAP (Gy.cm²)</th>
<th>Fluoroscopy Time (min)</th>
<th>No. of Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transjugular intrahepatic portosystemic shunt creation</td>
<td>3.00</td>
<td>525</td>
<td>60</td>
<td>300</td>
</tr>
<tr>
<td>Biliary drainage</td>
<td>1.40</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Nephrostomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For obstruction</td>
<td>0.40</td>
<td>40</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>For stone access</td>
<td>0.70</td>
<td>60</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Pulmonary angiography</td>
<td>0.50</td>
<td>110</td>
<td>10</td>
<td>215</td>
</tr>
<tr>
<td>Inferior vena cava filter placement</td>
<td>0.25</td>
<td>60</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Renal or visceral angioplasty</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without stent</td>
<td>2.00</td>
<td>200</td>
<td>20</td>
<td>210</td>
</tr>
<tr>
<td>With stent</td>
<td>2.30</td>
<td>250</td>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>Iliac angioplasty</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without stent</td>
<td>1.25</td>
<td>250</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>With stent</td>
<td>1.90</td>
<td>300</td>
<td>25</td>
<td>350</td>
</tr>
<tr>
<td>Bronchial artery embolization</td>
<td>2.00</td>
<td>240</td>
<td>50</td>
<td>450</td>
</tr>
<tr>
<td>Hepatic chemoembolization</td>
<td>1.90</td>
<td>400</td>
<td>25</td>
<td>300</td>
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<tr>
<td>Uterine fibroid embolization</td>
<td>3.60</td>
<td>450</td>
<td>36</td>
<td>450</td>
</tr>
<tr>
<td>Other tumor embolization</td>
<td>2.60</td>
<td>390</td>
<td>35</td>
<td>325</td>
</tr>
<tr>
<td>Gastrointestinal hemorrhage localization and treatment</td>
<td>3.80</td>
<td>520</td>
<td>35</td>
<td>425</td>
</tr>
</tbody>
</table>
**Effects in eye**

- Eye lens are highly RS.
- Coagulation of proteins occur with doses greater than 2 Gy.
- There are 2 basic effects:

<table>
<thead>
<tr>
<th>Effect</th>
<th>Sv single brief exposure</th>
<th>Sv/year for many years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detectable opacities</td>
<td>0.5-2.0</td>
<td>&gt; 0.1</td>
</tr>
<tr>
<td>Visual impairment (cataract)</td>
<td>5.0</td>
<td>&gt; 0.15</td>
</tr>
</tbody>
</table>

Cristalium is highly RS, moreover, it is surrounded by highly RS cuboid cells.
Measurement of eye lens dose

Source left LPS Berlin, right PTB Braunschweig
Importance of lateral protection

In TIPS especially right eye protection – different to other interventions
Protection of left eye – in TIPS protection of right eye is more important

ICRP: 20 mSv/a for eye lens !!!
Fig. 5 Average eye lens dose (in µSv) according to procedure and protection tools used

Data from Measurement in 30 TIPS of area dose products of Institute of Radiology-North of Klinikum Nuernberg and of Instituts of Radiology of University of Erlangen
Data from Measurement in 30 TIPS of area dose products of Institute of Radiology-North of Klinikum Nuernberg and of Institut of Radiology of University of Erlangen
30 – 50% of Interventionists develop lens opacities if working without eye protection

A real health risk. The interventionists with detectable opacities had been exposed to a significantly higher estimated cumulative lens radiation dose over their careers (8.3 Gy ± 5.4) than those without (3.0 Gy ± 2.9). The severity of lens opacification was also found to correlate with the absorbed dose (see Fig. 3).

Far from being harmless, these opacities are particularly associated with decrements in contrast sensitivity (see Fig. 4a/b) and may be associated with greater future visual disability.

ICRP & EU: new limit for occupational exposures

In 2011 the International Commission on Radiological Protection (ICRP) brought attention to the fact that tissue reaction effects can occur following lower exposures than previously thought: 0.5 Gy, 10 times lower than earlier estimates.

Accordingly, the ICRP has recommended a new occupational exposure limit of 20 mSv per year, averaged over 5-year periods, during which no single year may exceed 50 mSv. The European Union is set to enshrine this limit in an upcoming radiation protection directive.

We see the risk. Recent research findings indicate a significant risk of developing cataracts as a consequence of occupational exposure experienced by medical professionals performing fluoroscopical interventions.

In a recent study conducted at a medical congress, posterior subcapsular lens changes characteristic of ionising radiation exposure (see Fig. 1 & 2) were found to be prevalent amongst interventional catheterisation professionals.
How can I avoid radiation-induced lens injury?

**5 points that will keep your eyes safe**

- **Continued medical education**: regularly update your radiation protection training.
- **Observe radiation protection standards of practice**: observe occupational recommendations published by scientific medical societies.
- **Use the appropriate radiation protection tools**: in particular ceiling suspended screens (in correct position), mounted table shielding and protective eyewear (see. Fig. 5)
- **Use personal dosimeters**: one under the lead apron and a second over the apron to be able to estimate eye dose.
- **Regularly have your eyes examined**: a full ophthalmologic check with a detailed slit lamp examination of the posterior lens region is recommended.

The information contained in this campaign was taken from the following:

- Exposition of the Operator’s Eye Lens and Efficacy of Radiation Shielding in Fluoroscopically Guided Interventions. Galster M, Guhl C, Uder M, Adamus R; fortschr Röntgenstr. ???

**Don’t take the risk.** Interventional radiologists must take particular care of their eyes, due to their regular performance of high-dose procedures. During some interventions, such as haemodialysis, fistula treatment, or biliary interventions the IR is very close to the irradiated volume of the patient, sometimes with limited possibility of self-protection.

Up-to-date training, conscientious use of protective tools and careful dosimetry to evaluate lens dose must be pursued to maintain the health and functionality of the eye.
Am I at risk? A recent study in Germany measured the effectiveness of radiation protection tools for the eye lens dose during standard fluoroscopic interventions.

The exposure of the lens to about 100 – 550 µSv during radiologic interventions is only reduced marginally by only relying on under-table shielding. Adding mounted screens (especially suspended lead glass shields) greatly reduce the exposure, if adequately adjusted during the procedure.

Lead goggles complete the ideal protection for an IR, reducing exposure that has passed other shielding to minimum levels and protecting the eyes during maneuvers where other protection is impossible or impractical (see Fig. 5).

Fig. 6 Number of procedures necessary to exceed 20 mSv annual limit according to procedure and protection used

An avoidable risk. Fig. 6 shows an estimation of the number of procedures required to reach the newly proposed annual exposure limit of 20 mSv per year, according to protection used.

If conscientious protection of the eyes involving mounted shields, goggles and personal dosimetry is observed, IRs should easily manage to stay below the newly recommended occupational exposure limit of 20 mSv per year, even if performing frequent high dose procedures.

Staying below this limit reduces the health risk to the eyes to an acceptable minimum according to the current scientific status quo.
X ray protection
Body and shielding on the table
More protection by Overlapping lead layers

4x 0.5 mm lead Äquivalent

MANUFACTURED BY Scanflex Medical AB Sirad s.a.

Size: M
Mod. 6152
Pb. Front 0,50/100
Back 0,25/100
Scatter radiation above and below the table

Source: Günther – Thelen Interventional Radiology
Isodoses with and without lead shielding body and legs
0.4-0.8 mSv/h

4-8 mSv/h

Philips INTEGRIS HM3000
Area isodoses
On II or FD system tables

Recommandation of SSK, Heft 9 1997:

Highest dose near x ray tube
Importance of Under table x ray tube
Scatter radiation to protect of
Upgraded shielding
Lead glass shielding
Ceiling - mounted
RADPAD® Protective Shields

Reducing scatter radiation up to 80%

(Measurement of Intitute for medical physics Klinikum Nuernberg North)
RADPAD® 5300A Femoral Entry Shield

now also available for TIPS
Special lead shielding for interventions with jugular approach
Complete leg protection