Abstract. In this paper we present a case of radiologist working interventional procedures. He works numbers of interventional procedures, but we reported only percutaneous nephrostomy and percutaneous biliary drainage, which represent about 30% of his occupational exposure. Radiologist is occupationally exposed for eighteen years, and from 1995 has radiation injuries. From 1999. art. hypertension, cataracta complicata incipient., onychodystrophia and hyperkeratosis were presented. The most important were hand skin injuries. In routine personal dosemetry control low doses, less than 10 mGy per year, were recorded, so personal dosimetry and biodosimetry results were not in accordance. From that reason we performed additional measurements during a number of two procedures mentioned above and presented their results. Radiation exposure of radiologist hands during two hundred percutaneous nephrostomy and sixty-three percutaneous biliary drainage were reported. These number represented annual occupation engagement. During measurements we used thermo luminescence dosimeters (TLD) type CaF$_2$:Mn. We recorded hand equivalent dose of $221\,\mu$Sv in average per drainage, and $31\,\mu$Sv in average per nephrostomy.

1. Introduction

We noticed that different radiologists received various personal doses, especially hand and finger doses, during the same interventional procedures. Factors influencing the dose are in close connection with patients as are their age, sex and weight. We also noticed some other factors related to equipment and radiologist's technique and as well as screening time.

Medical stuff, occupationally exposed, is under permanent physical and biomedical monitoring according to radiation protection current regulatory papers as well as to good medical and radiation protection practices. Sometimes, due to different reasons, these two monitoring techniques give various results.

In this paper we presented the case of radiologist working various interventional procedures

2. Occupationally exposition in interventional radiology

Middle age radiologist, who was the subject of our investigation, performed various interventional procedures as were percutaneous nephrostomy (unilateral, bilateral, change of nephrostomy catheter), biliary drainage, percutaneous abscess/pseudocystic drainage and placement of an ureteric stent. Percutaneous nephrostomy and biliary drainage represent, in average, about 30% of his occupational exposure.

The radiologist is occupationally exposed in interventional radiology for a more than eighteen years. According to his medical documentation there were no hereditary important diseases in his family. He was healthy and had no visible, or clinical, signs of radiation lesions until 1993. Medical examination from 1993. showed regular biochemical and hematological parameters, except lower white blood cells, but still in expected range. Dry skin of hands was reported in the same year. From 1995. the radiologist was not answering for medical examination calls until 1999. when we founded art. hypertension, cataracta complicata incipient. ou.,
onychodystrophia and hyperkeratosis mani bilateralis. The most important were skin changes
which we considered as precancerogenes lesions. We tried to reevaluate radiologist
occupationally exposure because these changes could be considered as late effects of cumulative
occupational doses.

Cytogenetics test results did not show unstable chromosomal aberrations as parameter of recent
irradiation. Micronucleus tests showed significantly high rate of 46/1000 BN. In vitro
radiosensitivity was normal as the micronucleus rate was 198/1000 BN. All these results could be
considered as late effects of ionizing radiation exposure.

Whole body exposure measurements previously, under routine circumstances, were performed by
TLD type CaF$_2$: Mn. Dosimeters were worn under the lead apron. Personal electronic dosimeter
with Si diode, located under the apron, on the trunk of the individual, indicated the dose
equivalent to the shielded trunk of the body.

In the aim of investigation and received dose reconstruction we used nine TL badges and put
them at the unshielded and shielded regions of the body.

3. Materials and methods

All measurements were performed by calibrated TLD type CaF$_2$: Mn. X – ray beam was also
calibrated and traceable to national air kerma and absorbed dose primary standards of Federal
Bureau of Measures and Precious Metals. For beam verification we used primary ionization
chamber type ND 1006, produced by National Bureau of Measures (OMH) from Hungary, and
current integrator type NP 3000 produced by the same Bureau. This chamber participated in
supplementary international intecomparison in Bureau International des Poids at Mesures (BIPM)
in Sevres, France, so it was also traceable to international air kerma and absorbed dose in water
standards.

Field verification was performed in terms of air kerma under collimation conditions, which
assured minimization of unwanted scatter. For dose equivalent evaluation we used conversion
coefficients. These coefficients are strongly dependence from photon energy, angle of incidence
and also size and shape of backscatter medium so measuring uncertainty is increased.

Personal monitors were irradiated to a known value of dose equivalent while mounted on 30
cm x 30 cm x 15 cm slab (polymethyl methacrylate) PMMA phantom. An anterior to posterior
radiation conditions were simulated. TL dosimeters were previously calibrated under conditions
similar to working conditions from the standpoint of focus to skin distance as well as the presence
of all subjects in the room which could have any influence on beam scattering. All dosimeters
were put in tissue equivalent follies when we irradiated them in free-air with well-known air
kerma rate. We also performed measurements to obtain a real backscatter factor using various X-
ray tube potentials in the range of 85 to 90 kVp with X-ray tube in the over table position

During the interventional procedure we put personal monitors at seven places where we expected
higher doses (right and left eye, thyroid, neck, right shoulder, left and right hand) as well as on
two places where ordinary low doses (chest and gonads) were expected. In estimation of effective
dose we looked up them as single personal dosimeter at one specific place. We also used direct
reading electronic device with Si diode, type PDM -102 produced by Aloka, Japan, placed on
chest under the lead apron.
Calibration and check measurements, as well as interventional procedure were performed on the same machine, SHIMADZY X-ray apparatus type IDR-1000; model F-2 with 1 mm Al equivalent and maximum tube voltage of 150 kV. Medical staff was in proximity of patient undergoing a procedure.

In the two chosen procedures duration of the procedure nephrostomy was 15 min in average and drainage 20 min in average.

We used NCRP Rep.122 as well as ICRP Rep.47 for estimating $H_E$ in practice using personal monitors. [1,2]

4. Results

Observation of radiologist’s personal dosimetry documentation gave us information that the mean dose in conventional TL dosimetry was 10.52 mGy per year with dosimeter worn under the protective apron.

Electronic device worn under the apron. during one procedure recorded about 9 µSv per procedure.

Results of individual hand doses are given in table I.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Biliary Drainage</th>
<th>Nephrostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean hand dose per procedure [µSv]</td>
<td>221</td>
<td>31</td>
</tr>
<tr>
<td>Number of procedures per year</td>
<td>63</td>
<td>200</td>
</tr>
<tr>
<td>Screening time [min]</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Total hand dose per year [mSv]</td>
<td>13.9</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Our measurements results are comparable with other author’s results that reported similar cases.[3,4,5]

Estimated cumulative hand dose for eighteen years occupational exposure, based on measurements of these two procedures taking into account that they represent 30 % of total exposure, is about 3.3 Gy. Improving technique and reducing the number of procedures per radiologist could reduce this dose.

4. Conclusion

In interventional radiology total doses at the unprotected regions of the body, especially hands, can exceed the dose limits recommended by ICRP. Our results showed that hand doses for mentioned two procedures did not exceeded recommended dose limits but taking into account cumulative dose effects could cause radiation skin injuries and substantiate the need for both, medical and physical, monitoring in aim to keep doses as low as possible.

REFERENCES