OCCUPATIONAL HAND DOSES IN INTERVENTIONAL RADIOLOGY

V. Spasic Jokic[1], B. Djurovic[2], S. Lukac[3]
[1]Federal Bureau of Measures and Precious Metals, Belgrade, Yugoslavia
[2]Military Medical Academy, Belgrade, Yugoslavia
[3]Military Medical Academy, Belgrade, Yugoslavia

Abstract

In this paper we present a case of radiologist performing interventional procedures. Radiologist works for number 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, cataract complicata incip.ou., onychodystrophia and hyperceratosis mani bill. The most important are hands skin injuries. In ordinary dosimetric control low doses, less than 10 mGy per year, were recorded, so personal dosimetry results and biological results are not in accordance. For that reason we performed additional measurements during many procedures and in this paper we present results for two chosen procedures. Radiation exposure of radiologist hands during 200 percutaneous nephrostomy and 63 percutaneous biliary drainage per year are reported. Exposures were measured with thermoluminescent dosemeters (TLD) type CaF_2:Mn. Hands doses of equivalent of 221 μSv in average per drainage and 31 μSv in average per nephrostomy were recorded.

1. Introduction

Different radiologists at the same procedures show variation in their personal doses, specially the hand and finger dose in interventional radiology. Factors influencing the doses are: factors related to patients (age, sex, weight, etc.), factors related to eqipement and factors related to radiologists (technique, screening time, number of procedures, type of procedures, etc.).

Medical staff radiation exposure is under physical and biomedical monitoring due to radiologist protection. Sometimes, for different reasons, results of these two monitoring techniques are not in accordance.

In this paper we present a case of radiologist performing interventional procedures, as percoutaneus nephrostomy (unilateral, bilateral, change of a nephrostomy catheter), biliary drainage, percutaneous apscess/pseudocyst drainage and placement of an ureteric stent. Percutaneous nephrostomy and percutaneous biliary drainage represent about 30 % of his occupational exposure.

This radiologist is occupationally exposed in interventional radiology for 18 years. According to medical documentation in his family there were no hereditary important diseases. He was healthy and had no visible (or clinical) signs of radiation leasions until 1993. Medical examination from 1993 showed regular biochemical and hematological parameters, exept lower white blood cells (but still in the range of expected values). The same year physician registered dry skin of the hands. From 1995 the radiologist was not answering the calls for medical examinations until 1999. when we found: art. hypertension, cataract complicata incip. ou., onychodystrophia and hyperceratosis mani bill. The most important were skin changes which can be considered as precancerogenes lesions. We tried to re-evaluate this radiologist's occupationally exposure because these changes can be considered as late effects of cumulative occupational doses.

Cytogenetics tests results didn't show unstable chromosomal aberrations as parameter of recent irradiation. Micronucleus test showed significantly high rate - 46/1000. In vitro radio

sensitivity was normal (micronucleus rate was 198/1000). All these results can be considered as late effects of ionising radiation exposure.

Previous whole body exposure mesurements were performed by TLD type CaF_2:Mn worn under the lead apron. Under these circumstances, personal monitor located under the apron on the trunk of the individual indicates the dose equivalent to the shielded trunk of the body. Our measurements included nine dosemeters at unshielded and shielded parts of the body.

2. Materials and methods

All measurements were performed by calibrated TLD type CaF_2:Mn.

Calibration of the intensities of the radiation fields is traceable to the Federal Bureau of Measures and Precious Metals (further: FBMPM). The ionization chambers and electrometer used for field calibration are owned by national metrological institution FBMPM and are traceable to primary Yugoslav standards as well as to international standards. The intensity of the field is assessed in terms of air kerma with the field collimated to minimize unwanted scatter. Conversion coefficients from air-kerma to the dose equivalent vary as a function of photon energy, angle of incidence and size and shape of backscatter medium. Personal monitors are irradiated to a known value of dose equivalent while mounted on 30 x 30 x 15 cm slab (polymethylmethacrylate) PMMA phantom. An anterior to posterior radiation condition is simulated. Multiple personal monitors are irradiated to obtain informations on accuracy and precision. As there are limitations when we use radiation qualities as metrological standards which often differ from the radiation qualities that personal monitors encounter in the working circumstances which often cannot be fully characterized we used users beam for the calibration purposes. We also simulated working conditions from the stand point of distances from the beam focus as well as appropriate holders and all elements which can be found in roentgen room. All dosimeters were put in tissue equivalent folies when we irradiated them in free-air with well known air kerma.

We put personal monitors at seven places where we expected higher doses (right and left eye, thyroide, neck , right shoulder, left and right hand) as well as on two places where ordinary low doses (chest and gonades) 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 type PDM -102 Aloka placed on chest under the lead apron.

Medical examinations were performed according to recent regulatory papers for occupational exposure.

All measurements were performed on SHIMADZU X-ray apparatus type IDR-1000, model F-2 with 1mm Al equivalent and maximum tube voltage of 150 kV. In this work X-ray scatter radiation was produced at various X-ray tube potentials in the range of 85 to 90 kVp with X-ray tube in the overtable position. Medical staff were 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]

3. Results

Mean dose in conventional TL dosimetry was 10.52 mGy per year with dosemeter worn under the protective apron.
Electronic device recorded about 9 μSv per procedure also worn under the apron.
Results of individual hand doses are given in table I.

Table I. Radiologists individual hand dose measurements results

procedure	biliary drainage	nephrostomy
mean hand dose per procedure [μSv]	221	31
number of procedures per year	63	200
screening time [min]	20	15
total hand dose per year [mSv]	13.9	6.2

Our measurements results are comparable with other authors results who 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. This dose can be reduced by improving tehnique and reducing the number of procedures per radiologist.

4. Conclusion

In interventional radiology total doses at the unprotected parts 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 can cause radiation skin injuries and substantiate the need for both, medical and physical, monitoring in aim to keep doses as low as possible.

References

[1] NCRP Report No.122: Use of personal monitors to estimate effective dose equivalent and effective dose to workers for external exposure to low-LET radiation, NCRP, Bethesda (1995).
[2] ICRU Rep. No.47 Measurement of Dose Equivalents from External Photon and Electron Radiations, ICRU, Bethesda (1992).
[3] Ramsdale, W.J. Walker, P.W. Horton: Extremity doses during interventional radiology, Clin.Radiol.41(1) (1990) 34-36.
[4] E.Vano,L. Gonzales, E.Guibelalde,J.M.Fernandez,J.I.Ten: Radiation exposure to medical staff in interventional and cardic radiology, Br.J.Radiol. 71(849) (1998) 954-960.
[5] T.Vehmas: What factors influence radiologist' finger doses during percutaneous drainages under fluoroscopic guidance, Health Phys. 65(2) (1993)161-163.