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RESEARCH ARTICLE

DETERMINATION OF RADIATION EXPOSURE OF STUDENTS DURING THEIR INTERNSHIPS USING OSL DOSIMETER

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Abstract

To keep the radiation exposure under control is the golden rule for radiation protection. The internal structure of the human body could be visible thanks to radiology and nuclear medicine for the aim of diagnosis, and it was possible to destroy tumor cells with external radiation thanks to radiation oncology for the aim of therapy. Radiation dose monitoring is performed for radiation workers however no dose follow-up has for students. So, in this study it was aimed to determine the level of radiation exposure of students who trained in medical imaging techniques program. This work is assessed the radiation exposure of 132 students during their internships in the department of radiology, nuclear medicine and oncology with the aid of optically stimulated luminescence (OSL) dosimeters between the years of 2019-2017. The OSL dosimeters were sent to the RADKOR Personnel Dosimeter Systems Laboratory (Ankara, Turkey) for measurement. Exposed OSL dosimeters were read according to the laboratory specific method based on IEC 62387. Equivalent doses are defined as for body Hp(10) and skin Hp(0,07). Also Hp(10) and Hp(0,07) are defined in the body of each person considered, their values vary from one person to another and also depend on the location on the body where the dosemeter is worn. For the students in the roles of trainers, maximum accumulated equivalent doses were found to be 2.07 and 2.14 mSv for body Hp(10) and skin Hp(0.07), respectively. The minimum accumulated equivalent dose was 0.00 mSv for 112 students both body and skin. The mean Hp(10) and Hp(0,07) for the 1st, 2nd, 3rd and 4th periods were calculated as 0.23±0.38mSv and 0.20±0.35mSv, 0.27±0.42mSv and 0.23±0.34mSv, 0.18±0.37mSv and 0.12±0.30mSv, 0.22±0.63mSv and 0.04±0.34mSv, respectively. The results were evaluated with reference to the Radiation Safety Regulation reported by IAEA. According to the regulation, the effective dose for radiation officers cannot exceed 20 mSv for the whole five consecutive years, and 50 mSv for any year. The annual equivalent dose limit for hand and foot or skin is 500 mSv and 150 mSv for the eyepiece. Therefore, it was determined that all absorbed doses found under the radiation safety regulations. However, it was seen that some students whose absorbed dose were found a little bit high acted more courageous with the self-confidence.

Keywords: Radiation exposure, OSL, absorbed dose, whole body exposure, skin exposure, radiation safety

1. INTRODUCTION

Medical imaging and treatment with ionizing radiation has been used all over the world since 1931 (Reed, 2011). The internal structure of the human body could be visible thanks to radiology and nuclear medicine for the aim of diagnosis, and it was possible to destroy tumor cells with external radiation thanks to radiation oncology for the aim of therapy. Radiology has basically used four methods as X-ray device, computed tomography (CT), magnetic resonance (MR), ultrasonography (US) and angiography devices such as fluoroscopy for imaging via external radiation. Nuclear medicine is defined a science where radioisotopes are applied to patients for diagnosis generally and for treatment rarely. In scintigraphic applications called diagnostic images in nuclear medicine, there is a need for a bioactive agent that will allow the radioisotope to be transported to the desired organ in the body. The molecule formed by combining radioisotope and bioactive agent is called radiopharmaceutical. Nuclear medicine has included four methods as Gamma camera, Single Photon Emission Computerized Tomography (SPECT) and Positron Emission Tomography (PET) or their combined version with CT or MR as PET/CT, SPECT/CT, PET/MRI for imaging via internal radiation. Radiation oncology, as a anticipant of personalized clinical oncology, has improved individualized therapies based on anatomical information combined with clinical parameters (Bernier, 2004), (Verellen, 2007). The goal of curative radiotherapy is to sift all cancer stem cells (defined here as recurrent tumor cells) in the primary tumor and regional lymph nodes (Baumann, 2008), or in oligometastatic disease (Weichselbaum, 2011), while limiting damage to normal tissues. For this aim, oncology has used some devices such as LINAC, Cyber-knife, gamma knife, TrueBeam STx and Tomotherapy for therapy via external radiation.

All these applications benefit from the destruction caused by ionizing radiation in the cell, however, as a result of this, the probility of radiation damage to healthy tissues and organs or determination of level of radiation exposure to workers and patients comes into question. For this reason, radiation dosimetry is a main need in all medical applications of radiation. At this point, some dosimeters have been developed and they have proved to be a very significant tool in radiology, nuclear medicine and oncology for monitoring of personnel and environmental ionizing radiation (Loya, 2016).

Personal dosimeters are needed to measure exposure levels of workers working in a radiation environment. Thermoluminescence dosimetry (TLD) and optically stimulated luminescence dosımetry

(OSL) are widely used as personal dosimetry (Gilvin, 2015), (Botter-Jensen et. al., 2003) When dosimetry type is preferred, stable radiation sensitivity, resistance to external factors, tissue compatibility, ergonomic properties, cost and reading procedures are taken into consideration (Fellinger, 1984), (McKeever, 2001). Reusability, accurate dose reading, low effect from external factors and local stimulation are the advantages of OSL dosimeter (Sommer, 2006). Especially, beryllium oxide material stands out due to its near tissue equivalence (Zeff = 7.14) (Sommer, 2006) (Jahn, 2010), energy response, high sensitivity and low cost (Sommer, 2006). In view of these advantages, OSL dosimeters with beryllium oxide were preferred generally. The OSL dosimeter ensures a very high degree of sensitivity by giving an true reading as low as 1 mrem for ionising photons with energies between 5 keV and more than 40 MeV (Statkiewicz-Sherer, 2018).

In this study it was aimed to determine and evaluate the level of radiation exposure of students who trained in medical imaging techniques program.

2. MATERIAL AND METHODS

In the study, total number of 132 students (90 Female, 42 Male) who were educated in Altınbaş University Medical Imaging Techniques Program between 2019-2017 were included. The average age of the students was 18.50 (range between 25-17). Students were assigned to do internships in radiation oncology (132/23), nuclear medicine (132/6) and radiology (132/103). To estimate the equivalent dose from external exposure, all students had OSL dosimeters with BeO crystal. OSL dosimeters were given to the students for 1 period consists of 2 months. Equivalent doses are defined as for body Hp(10) and skin Hp(0,07). Also Hp(10) and Hp(0,07) are defined in the body of each person considered, their values vary from one person to another and also depend on the location on the body where the dosemeter is worn (Dietze, 2000). The study included Hp(10) whole body and Hp(0,07) skin dose measurements (mSv) of 52 students for just 1 period, 37 students for 2 periods, 33 students for 3 periods and 10 students for 4 periods. 1st, 2nd, 3rd and 4th periods were consisted of number of 43 ,80 ,132 and 10 students, respectively.

2.1. Usage of OSL

All students were given guidelines on the use of OSL dosimeters before the internship. OSL dosimeters were usually affixed on the outside of clothing, around the chest or torso. The OSL dosimeter was worn under the lead apron only when a student used a lead apron. OSL dosimeters were never tried to open and not removed from its sleeve. Outside the daily working hours, OSL dosimeters were kept away from radiation, not exposed to heat, humidity and pressure. At the end of the internship, the dosimeters were collected from the students.

2.2. Conditions of Departments

The number of 23 students doing internship in radiation oncology participated in chemotherapy practices. They also participated in the treatment practice with the CIRUS 60Co teletherapy machine. The number of 6 students who interned in the nuclear medicine department participated in scintigraphic imaging procedures performed with the 99mTc radioisotope. They worked as observers in patient preparation and radioactivity injection practices. The students alternately participated in the practice in the PET room, which contained high energy isotopes as 18F. The number of 103 students, who were doing their internships in the radiology department, completed their internships in the X-ray and tomography rooms.

2.3. Dose Reading of OSL

The OSL dosimeters were sent to the RADKOR Personnel Dosimeter Systems Laboratory (Ankara, Turkey) for measurement. Exposed OSL dosimeters were read according to the laboratory specific method based on IEC 62387 (International Electrotechnical Commission, 2007).

2.4. Evaluation of Doses

The results were evaluated with reference to the Radiation Safety Regulation reported by IAEA (IAEA, 1999). According to the regulation, the effective dose for radiation officers cannot exceed 20 mSv for the whole five consecutive years, and 50 mSv for any year. The annual equivalent dose limit for hand and foot or skin is 500 mSv and 150 mSv for the eyepiece.

3. RESULTS

It was determined that 4 out of 132 students in the 1st period, 41 out of 80 students in the 2nd period, 14 out of 43 students in the 3rd period and 2 out of 10 students in the 4th period were used their OSL dosimeters regularly.

Exposed OSL dosimeters with different doses of X-rays and gamma radiation caused by radiology via X-ray machine and tomography shots, by nuclear medicine via SPECT and PET shots using radioactive sources such as 99mTc, 18F, by radiation oncology via 60Co teletherapy system were placed in the OSL reader to obtain their response in relation to radiation dose. The results of exposed OSL dosimeters for all students were shown detailed in Table 1.

Table 1: The whole body Hp (10) and skin Hp (0,07) doses for all students.

		1st period		2nd period		3rd period		4th period	
Number	*Department of Internship*	*Hp (10) (mSv)*	*Hp (0,07) (mSv)*	*Hp (10) (mSv)*	*Hp (0,07) (mSv)*	*Hp (10) (mSv)*	*Hp (0,07) (mSv)*	*Hp (10) (mSv)*	*Hp (0,07) (mSv)*
#1	R	0.28	0.30	0.32	*0.35	0.32	0.38		
#2	R	0.33	0.31	0.36	*0.35				
#3	R	0.34	*0.37	*0.73	*0.37				
#4	R	0.37	0.35	*0.48	0.24				
#5	R	0.29	0.30	*0.68	0.29				
#6	R	0.26	0.28	*0.46	0.30				
#7	R	0.30	0.33	*0.94	*0.38				
#8	R	0.31	0.34	0.00	0.00	0.24	0.25		
#9	R	0.21	0.25	0.00	0.00				
#10	R	0.27	0.27	*0.61	0.32				
#11	R	0.33	0.33	0.00	0.00				
#12	R	0.28	0.30	0.00	0.00				
#13	R	0.31	0.33	0.00	0.00	*0.43	*0.56		
#14	R	0.32	0.34	0.00	0.00				
#15	R	0.32	0.34	0.00	0.00				
#16	R	0.37	*0.39	0.00	0.00	0.32	*0.37		
#17	R	0.33	*0.36	0.00	0.00	0.25	*0.35		
#18	R	0.34	0.33	0.30	0.30	0.00	0.00	0.32	*0.36
#19	R	0.29	0.32	0.00	0.11	0.21	0.25		
#20	R	0.32	0.35	0.00	0.00	0.37	*0.41		
#21	R	0.34	0.34	0.29	0.30	0.00	0.00	0.30	*0.36
#22	R	*0.4	*0.39	0.34	*0.43				
#23	R	0.29	0.30	0.29	0.32				
#24	R	0.30	0.34	0.26	0.26	0.30	*0.34		
#25	R	0.38	*0.42	0.00	0.00	0.12	0.11		
#26	O	0.35	*0.36	0.00	0.00	0.00	0.00		
#27	O	0.28	0.30	0.00	0.00	0.00	0.00		
#28	O	*0.39	*0.39	0.30	0.31	0.00	0.00	0.00	0.00
#29	O	*0.40	*0.41	0.33	0.34	0.00	0.00	*0.72	*0.41
#30	R	0.35	*0.38	0.25	0.31				
#31	NM	0.28	0.30	0.00	0.00				
#32	O	0.26	0.27	0.00	0.00	0.07	0.07		
#33	NM	*0.41	*0.44	0.05	0.05				
#34	NM	*1.22	*1.26	0.00	0.00	0.34	*0.38		
#35	O	0.32	0.33	0.36	*0.37	0.00	0.00	0.00	0.00
#36	O	*2.07	*2.14	0.00	0.00				
#37	O	0.35	*0.38	0.30	0.31	0.25	0.29		
#38	O	0.29	0.30	0.00	0.00				
#39	O	0.29	0.32	0.28	0.31				
#40	R	0.32	0.33	0.00	0.00				
#41	R	0.30	0.33	0.00	0.00				
#42	O	0.36	*0.37	0.32	0.33	*0.59	*0.38		
#43	O	0.36	*0.37	*0.98	0.27				
#44	R	0.33	0.35	*0.65	0.30				
#45	R	0.33	*0.36	0.27	0.28	0.30	*0.35		
#46	R	0.30	0.32	0.39	*0.40	0.00	0.00	*0.85	0.33
#47	R	0.30	0.33	0.00	0.00	*0.60	*0.35		
#48	R	0.34	*0.38	0.32	*0.35	*0.56	*0.43		
#49	R	*0.53	*0.61	0.00	0.00				
#50	R	0.33	0.32	0.34	*0.37	*0.48	0.25		
#51	R	*0.39	*0.37	0.28	0.33	*0.65	*0.39		
#52	R	0.33	0.35	*0.59	*0.39				
#53	O	0.28	0.31	0.00	0.00	0.00	0.00		
#54	R	0.34	*0.37	0.00	0.00	*0.63	0.3		
#55	R	0.35	*0.37	0.32	0.33	0.00	0.00	0.55	0.29
#56	R	0.32	0.34	*1.25	*0.36				
#57	R	0.27	0.30	0.00	0.00				
#58	R	0.33	0.35	0.00	0.00				
#59	R	0.36	*0.39	0.00	0.00	*0.67	*0.39		
#60	R	0.29	0.30	0.00	0.00	0.06	0.05		
#61	R	0.29	0.31	*0.43	*0.48	*0.50	*0.34		
#62	R	0.29	0.30	0.28	0.27	*0.40	0.24		
#63	R	0.30	0.33	0.00	0.00				
#64	R	0.24	0.32	0.00	0.00				

#65	R	0.31	0.35	0.30	0.31	0.00	0.00	*0.87	0.32
#66	R	0.28	0.29	0.26	0.28	0.00	0.00	*0.83	0.31
#67	R	0.37	0.35	0.00	0.00				
#68	O	0.27	0.31	0.25	0.26	0.00	0.00	0.56	0.32
#69	O	0.32	0.34	0.00	0.00				
#70	O	0.30	0.34	0.00	0.00	0.00	0.00		
#71	NM	0.36	*0.37	0.00	0.00	0.09	0.08		
#72	NM	0.36	0.32	0.00	0.00				
#73	NM	0.36	*0.37	0.00	0.00				
#74	O	0.36	*0.39	0.36	*0.39	*0.63	*0.37		
#75	R	*0.40	*0.40	0.40	*0.39	*0.55	*0.31		
#76	R	*0.46	*0.48	0.07	0.06	0.16	0.15		
#77	R	0.33	*0.36	0.00	0.00	*0.43	0.27		
#78	R	0.37	*0.38	0.00	0.00	0.22	0.25		
#79	R	0.31	0.34						
#80	R	0.32	0.33						
#81	R	0.29	0.32						
#82	R	0.32	0.34	1.22	*1.72				
#83	O	0.33	0.35						
#84	R	*0.39	*0.38						
#85	R	0.35	*0.36						
#86	R	0.35	*0.37						
#87	R	0.00	0.00						
#88	R	0.00	0.00						
#89	R	0.00	0.00	0.06	0.05				
#90	R	*0.55	0.27						
#91	R	*0.94	*0.82						
#92	R	*0.48	0.32						
#93	R	*0.53	0.33						
#94	R	*1.10	0.34						
#95	R	*0.43	0.32						
#96	R	*0.51	0.34						
#97	R	*0.56	0.35						
#98	R	*0.61	*0.38						
#99	R	*0.44	0.28						
#100	R	*0.62	*0.37						
#101	R	*0.43	0.27						
#102	R	*0.54	0.27						
#103	R	*0.66	*0.38						
#104	R	*0.56	*0.39						
#105	R	*0.54	0.31						
#106	R	*0.45	0.34						
#107	R	*0.39	0.23						
#108	R	*0.74	0.30						
#109	R	*0.61	0.31						
#110	R	*0.66	0.35						
#111	R	0.27	0.29						
#112	R	0.33	*0.38						
#113	R	0.35	*0.37						
#114	R	0.34	*0.41						
#115	R	0.28	0.30						
#116	R	0.00	0.00						
#117	O	0.09	0.08						
#118	R	0.05	0.05						
#119	R	0.08	0.07						
#120	O	0.07	0.06						
#121	O	0.05	0.05						
#122	O	0.08	0.07						
#123	O	0.09	0.09						
#124	R	0.06	0.05						
#125	R	*0.57	0.33						
#126	R	0.27	0.32						
#127	R	0.25	0.29						
#128	R	0.30	*0.37						
#129	R	*0.41	0.29						
#130	R	*0.50	0.29						
#131	R	*0.88	0.31						
#132	R	*0.48	0.20						
Mean (mSv):	**0.38**	**0.35**	**0.42**	**0.34**	**0.37**	**0.30**	**0.63**	**0.34**	
S.D (±):		0.23	0.20	0.27	0.23	0.18	0.12	0.22	0.04

R: Radiology, O: Oncology, NM: Nuclear Medicine, * high dose values than means.

All calculations were made by subtracting 34 students who did not use dosimetry. The mean whole body Hp(10) and skin doses Hp(0,07) for the 1st, 2nd, 3rd and 4th periods were calculated as 0.23±0.38mSv and 0.20±0.35mSv, 0.27±0.42mSv and 0.23±0.34mSv, 0.18±0.37mSv and 0.12±0.30mSv, 0.22±0.63mSv and 0.04±0.34mSv, respectively. Considering total number of 204 period measurements, the result of 34 measurements were above the mean values. It was seen that 26 of these high values were in radiology, 6 in oncology and 2 in nuclear medicine. The maximum accumulated equivalent doses obtained were found to be 2.07 and 2.14 mSv for body Hp(10) and skin Hp(0.07) in one student numbered as 36#.

It was observed that the average whole body and skin doses that the students were exposed to during their internship were equal to approximately 1 percent and 1 in a thousand of the stated reference reported by IAEA.

4. DISCUSSION

Monitoring of radiation exposure of personnel or student has several purposes. Work planning can be made by looking at the level of radiation and information about the external radiation exposure of the personnel is obtained. In addition, these results can be used to keep radiation exposure as low as reasonably possible (Lundberg, 2002). In our study, it was observed that suitable working environment as distance was provided in clinics according to the radiation doses that the students were exposed to. Though all of the students were aware of the importance of radiation safety, however, important errors were found in the application and information about it. The lack of standard radiation safety equipment for students was a major concern.

Although all students were given written guidelines on the use of OSL dosimeters before the internship, it was observed that 2 students in the 1st period, 33 students in the 2nd period, 14 students in the 3rd period and 2 students in the 4th period did not use the OSL dosimeter. It is thought that students are insensitive to written instructions and behave unnecessarily confident in the clinic based on their theoretical knowledge.

This study found that medical imaging techniques program's students who are legally non occupational exposed group (ICRP, 2007), are exposed to ionizing radiation without risk detection. So, It was stated that students who trained in medical imaging techniques program of vocational school of health sciences were not at risk by X-ray exposure since their university training years.

Finally, absorbed dose values obtained in this work may be compared to results from (Loya, 2016), the doses showed in this paper were found to be quite low.

5. CONCLUSION

The fact that students do not use dosimetry during their internship causes inability to follow up the dose. For this reason, it is recommended that students be briefed before the internship. The necessary information about the importance of the use of dosimeters and the method of use should form the basis of the briefing. However, students are exposed to low radiation doses and complete their internships within safe limits. It should be considered that the use of dosimetry is mandatory for a possible radiation accident.

Many hospitals still lack lead shielding materials as lead apron, thyroid sparing, is low. Future efforts should involve minimizing radiation exposure in the department of radiology, radiotherapy and nuclear medicine, and more interest in wearing and preparing protective equipment is needed.

6. REFERENCES

Baumann, M. K. 2008. Exploring the role of cancer stem cells in radioresistance, Nat. Rev. Cancer, -545 554.

Bernier, J. H. 2004. Radiation oncology: a century of achievements, Nat. Rev. Cancer, 747-737.
Botter-Jensen, L., S.W.S Mckeever, and A.G. Wintle. 2003. Optically Stimulated Luminescence Dosimetry, Published by Elsevier.

Dietze, G. 2000. Dosimetric Concepts and Calibration of Instruments.

Fellinger J., H. J. 1984. Calculation and experimental determination of the fast neutron sensitivity of OSL detectors with hydrogen containing radiators, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 156-154.

Gilvin P.J., A. J. 2015. Quality Assurance in Individual Monitoring for External Radiation, Neuherberg: EURADOS.

IAEA. 1999. Occupational Radiation Protection, No: RS-G1.1-. Vienna: IAEA.

ICRP. 2007. The 2007 Recommendations of the International Commission on Radiological Protection, ICRP publication 103. Pergamon Press, Oxford, UK.

International Electrotechnical Commission. 2007. International Standard IEC 1-62378. Geneva: IEC.
Jahn, A., M. Sommer, and J. Henniger. 2 .2010D-OSL-dosimetry with beryllium oxide, Radiation measurements, 676-674.

Loya, M., L.H. Sanin, P.R. Gonzalez, O. Avila, R. Duarte, S. L. Ojeda, M.E. Montero-Cabrera. 2016. Measurements of radiation exposure of dentistry students during their radiological training using thermoluminescent dosimetry, Applied Radiation and Isotopes, 238-234.

Lundberg, T.M., P.J. Gray, M.L. Bartlett. 2002. Measuring and minimizing the radiation dose to nuclear medicine technologists. J Nucl Med Technol, 30-25.

McKeever, S. 2001. Optically stimulated luminescence dosimetry, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 54-29.

Reed, A. 2011. The history of radiation use in medicine, Journal of Vascular Surgery, 5-3.

Sommer, M., J. Henniger. 2006. Investigation of a BeO-based optically stimulated luminescence dosimeter, Radiat. Prot. Dosimetry, 397-394.

Sherer, M.A.S., P.J. Visconti, E.R. Ritenour, K. Haynes. (2018). Radiation Protection in Medical Radiography, Elsevier, Missouri.

Verellen, D.D. 2007. Innovations in image-guided radiotherapy, Nat. Rev. Cancer, 960-949.
Weichselbaum, R.H. 2011. Oligometastases revisited, Nat. Rev. Clin. Oncol., 382 -378.