Original Article

Investigation of patient dose from common radiology examinations in Isfahan, Iran

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Abstract

Background: The aim of this study was measurement of the radiation doses received by patients for common radiology examinations in hospitals under control of Isfahan University of Medical Sciences, Iran.

Materials and Methods: Thermoluminescence (lithium fluoride chips, LiF: Mg, Tl) dosimeter was used to measure patient dose for four (chest, posterior-anterior and lateral and skull anterior-posterior, or posterior-anterior and lateral) common radiographic views in six hospitals (seven X-ray machines). The entrance surface dose was measured on 20 randomly patients for each X-ray room.

Results: The maximum (8.85 ± 0.62 mGy) and the minimum (0.62 ± 0.22 mGy) values of ESD was obtained for X-ray machines of Shimadzu and Varian located in Ashrafi-Khomeini-shahr and Kashani hospitals, respectively. As results shows, the values of ESD of skull were higher than that of chest examinations.

Conclusion: The results of this study indicated that ESD measured doses were slightly greater than the ICRP and NRPB reference doses. Efforts should be made to further lower patient doses while securing image quality. In addition, the need to provide relevant education and training to staff in the radiology sections is of utmost importance.

Key Words: Diagnostic radiology, patient dose, X-ray examinations

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INTRODUCTION

The diagnostic X-ray radiology is a very common diagnostic practice and recently there has been a substantial increase in number of examinations.[1] The National Radiological Protection Board (NRPB) identify the diagnostic radiology (DR) as an area of special concern.[2] NRPB reported that approximately 90% of the total population dose is contributed from the patients undergoing conventional X-ray examinations, constituting the most significant manmade source of radiation exposure for the world population. Moreover, International Commission on Radiological Protection[3] is concerned with the control of the manner in which DR are used so that the user and also members of the public are not irradiated above acceptable levels recommended by the ICRP.[4]

Measurements of the patient doses are very important from the radiation safety point of view and can be a useful tool to detect problems in the clinical practice. If

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the doses are higher than expected, then they indicate possible problems in optimization of either equipment or procedures.

During the past two decades, several dose surveys have been performed for the study of patient radiation doses in many countries around the world.[5-7]

In some countries, especially in China[8] and Tanzania[9] researchers reported that, compared to ICRP reference doses, the average ESDs were comparatively high for X-ray examination. While in the United States,[10] Greece,[11,12] Brazil,[13] and Bangladesh[14] investigations showed that patients dose from common X-ray examination were below the ICRP reference doses.

At this study to investigate the radiation safety of the patients and possible problems in clinical practice during the DR examinations, entrance surface dose (ESD) to the patients in the most common DR examinations in Isfahan hospitals, such as chest radiograph (posterior-anterior, PA and lateral projections, LAT) and skull (anterior-posterior, AP or PA and LAT) were measured. ESD is the dose to the skin surface from an X-ray examination.

According to the best of our knowledge, this work is the first to investigate ESD of the patients undergoing routine X-ray procedures in hospitals under control of Isfahan Medical Sciences University, Iran.

MATERIALS AND METHODS

To collect the data, seven hospitals (Alzahra, Ashrafi-Khomeini-shahr, Feyz, Isabne-Maryam, Kashani, Nour-Aliasghar, and Seyed-Al Shohada) and six stationary X-ray machines (General electric- USA, Phillips- Netherland, Siemens- Germany, Shimadzu-Japan, Toshiba- Japan, and Varian- USA) were investigated. The study was approved by the Radiology Research Board at the Isfahan University of Medical Sciences, Isfahan, Iran. Study protocol was done in according to the previous work in Chaharmahal and Bakhtiari, Iran.[15] The ESD measurements were performed on 20 randomly selected adult patients for each DR room, with mean age of 50.1 years (ranges from 19–80 years, 140 patients in total included 49 male and 91 female) for each X-ray machine.

At this study, thermoluminescent dosimeters (TLDs) [LiF TLD-100] were used for dose measurements. All TLDs were calibrated in the Dosimetry Laboratory of the Isfahan University of Medical Sciences. TLDs were dose calibrated with a ^{60}Co source located in the radiotherapy section of Seyed Al-shohada hospital of Isfahan, Iran. All TLD doses were read using the Solaro 2A Reader located in the Department of Medical Physics of Isfahan University of Medical Sciences. All of them were appended manually to the spreadsheet to provide an alternate assessment of the quantity absorbed dose (including backscatter) at the patient surface. Thermoluminescence dosimeter were mounted on a tape and placed on center of X-ray beam on the patient's skin. Therefore, the backscatter radiation was included in the record surface dose. For dose measurements, the doses were averaged for each radiography and mean of ESD of all patients calculated using the SPSS version 14 software (SPSS Inc, Chicago, IL). The exposure data such as kVp, mAs, the type of cassette and the focal source distance for each examination were also recorded. For all mentioned hospitals and X-ray machines, the average value of ESD using TLD for each routine examination was calculated. Finally, the result of this study was compared with the other reported data of relevant organizations.

RESULTS

The results of the ESD measurements are indicated

Table 1: The measured ESD values for six X-ray machines and seven hospitals using thermoluminescent dosimeter

X-ray machine	Name of Hospitals	Chest AP ESD (mGy)	Chest LAT ESD (mGy)	Skull AP ESD (mGy)	Skull LAT ESD (mGy)
General Electric	Feyz	0.72 ± 0.38	2.93 ± 0.51	6.78 ± 0.25	8.08 ± 0.58
Phillips	Alzahra	0.66 ± 0.24	2.32 ± 0.28	7. 28 ± 0.74	6.97 ± 0.42
	Alzahra	0.65 ± 0.14	2.53 ± 0.59	6.08 ± 0.58	6.78 ± 0.45
Shimadz u	Ashrafi-Khomeini-shahr	0.70 ± 0.37	2.48 ± 0.36	6.15 ± 0.36	8.85 ± 0.62
	Kashani	0.62 ± 0.22	2.43 ± 0.15	7.21 ± 0.31	7.63 ± 0.90
	Nour-Aliasghar	0.69 ± 0.21	2.40 ± 0.52	7. 32 ± 0.96	8.21 ± 0.61
Siemens	Nour-Aliasghar	0.70 ± 0. 14	2.50 ± 0.36	7. 15 ± 0.62	8.45 ± 0.36
Toshiba	Isabne-Maryam	0.70 ± 0. 13	2.81 ± 0.37	7.36 ± 0.46	8.57 ± 0.35
	Kashani	0.66 ± 0. 41	2.5 7 ± 0.58	6.10 ± 0.76	7.64 ± 0.74
Varian	Isabne-Maryam	0.67 ± 0.52	2.73 ± 0. 61	6.14 ± 0.19	6.52 ± 0.43
	Kashani	0.64 ± 0.41	2.12 ± 0. 81	6.97 ± 0.42	7.12 ± 0.70
	Seyed-Al Shohada	0. 70 ± 0.32	2.74 ± 0. 40	6.52 ± 0.48	8.14 ± 0.12

Table 2: The exposure parameters and the values of the ESD (mean and range) for four routine X-ray examinations using TLD (40 experiments for each type of examination)

Type of examination	No. of exams	kVp	Ranges of ESD (mGy)	Mean of ESD (mGy)
Chest PA	40	70–80	0.32-1.95	0.74 ± 0.12
Chest LAT	40	75–85	0.44-3.90	2.21 ± 0.43
Skull PA/AP	40	85–90	2.05-8.65	6.84 ± 0.71
Skull LAT	40	85–90	2.81-9.70	7.89 ± 0.65

in Table 1 for adult patients those who were randomly selected for X-ray examinations at different hospitals. As can be seen from this table, the maximum (8.85 ± 0.62 mGy) and the minimum (0.62 ± 0.22 mGy) values of ESD was obtained for X-ray machines of Shimadzu and Varian located in Ashrafi-Khomeini-shahr and Kashani hospitals, respectively. Whereas the former was measured in the Skull LAT and the latter was measured in Chest AP examinations. The exposure parameters and the ESD values for all routine X-ray examinations are shown in Table 2. For certain X-ray examinations, particularly chest and skull, mean generating voltages (kVp), and mean entrance surface doses are presented. As results shows, the values of the ESD of skull were higher than that of chest examinations.

DISCUSSION

Records of medical examinations and personnel monitoring must be kept and made available to medical advisers, employing authorities, and government health inspectors. At this study, the results of the patient ESD measurements are presented for hospitals under control of Isfahan University of Medical Sciences.

The results of this study showed that the ESD of patients in Isfahan was comparable to the results previously reported in Chaharmahal and Bakhtiari[15] and those reported in Tanzania[9] Shahbazi found that in Chaharmahal and Bakhtiari the value of ESD for skull LAT and chest AP were in the range of 7.58–9.12 mGy and 0.22–1.45 mGy, respectively. In Tanzania, Muhogora *et al.* reported that the value of ESD for these examinations was to be in the range of 0.08–0.56 mGy. While, the value of ESD measured at this study was significantly greater than those recorded in some other countries such as the United States,[10] Greece,[11,12] Brazil,[13] and Bangladesh.[14] In Greece, the mean values of ESD were found to be 0.044 mGy for chest PA and 0.043 mGy for chest LAT. In Brazil mean values of ESD for PA and LAT projections were 0.22 and 0.98 mGy, respectively.

Moreover, it was also found that the ESD increased with the number of patients examined per day. In Seyed-Al Shohada and Ashrafi-Khomeini-shahr hospitals, the number of patients examined per day for X-ray units were significantly higher than those in other hospitals (more than two to three times).

The exposure parameters and the ESD values for all routine X-ray examinations are shown in Table 2. For certain X-ray examinations, particularly chest and skull, mean generating voltages (kVp) and mean ESDs are presented. The results of the measurements between different X-ray examinations showed that the values of the ESD of the high tube potential technique (such as skull) were significantly higher than that of chest examinations by factors of 2.5 to 10. In addition, the findings here also evident that the older X-ray equipment (such as X-ray machine located in Seyed-Al Shohada hospital with more than 20 years may) result the higher ESD values.

Considering these results and in order to optimize the protection of patients in the most cost-effective manner, a process should performed consist of the quality assurance including quality control programs to reach as low as reasonably achievable dose conditions. Therefore, quality assurance programs should be undertaken to avert considerable cost and high patient doses.

In addition to the above mentioned, the dose levels found in this study could be attributed to another number of factors. In patient dosimetry in diagnostic radiology, dose measurements are normally made for the standard-sized patient, that is, of weight close to 70 kg, and for a statistical significant number of patients, that is, a minimum of 10 patients per room.[2] These requirements were rarely fulfilled in this study. Moreover, the unacceptable over-exposure films were excluded from the study.

Efforts should be made to further lower patient doses while securing image quality. In addition, the need to provide relevant education and training to staff in the radiology sections is of utmost importance. Moreover, the findings of this work can be used as a baseline upon which future dose measurements may be compared. The results are also useful to national and professional organizations. They are expected to encourage further dose surveys in the area of diagnostic radiology.

CONCLUSION

At this work, the results of the patient doses in diagnostic radiology in Isfahan are presented. The results showed that the dose of patients undergoing common radiology examinations in Isfahan hospitals

is greater than the ICRP and the measured data in other countries. Efforts should be made to further lower patient doses while securing image quality. In addition, the need to provide relevant education and training to staff in the radiology sections is of utmost importance.

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