นิพนธ์ต้นฉบับ

Study of patients' surface doses taking radiographs for medical examinations

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Background : *In 1995 the International Atomic Agency designed a coordinated research program on the study of radiation doses in diagnostic radiology in Asia and the Far East countries. The agency aimed to reduce dosage to population and gave financial support to this study in Thailand.*

Objective : *To determine the entrance surface doses of adult patients undergoing seven types of general x-ray examinations in fours hospitals and compare to doses recommended by the Commission of the European Communities.*

Setting : *Department of Radiology of Chulalongkorn Hospital, Ramathibodi Hospital, Siriraj Hospital and Nakornpathom Hospital.*

Subjects : *Two hundred and eigthy patients who had general x-ray examination.*

Design : *Retrospective study.*

Patients : *Patients were selected if their weights were 55-75 kilogram. Seven types of examination, ten patients per type of examination per hospital.*

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Methods : *The study was made by using the thermoluminescent dosemeter to measure the entrance surface dose. Both dosimeter and reader were calibrated by primary standard laboratory for precision of readings.*

Results : *The mean entrance surface doses of the patients were 0.26±0.14 milliGray for Chest PA; 0.97±0.48 milliGray for Chest Lat; 2.81±2.09 milliGray for Lumbar spine AP; 7.97±5.32 milliGray for Lumbar spine Lat; 1.37±0.8 milliGray for Skull PA; 1.09±0.65 milliGray for Skull Lat and 1.59±1.08 milliGray for Pelvis AP.*

Conclusion : *The measured entrance surface doses were less than the doses recommended by the Commission of the European Communities. However the exposure could be reduced as low as reasonable achievement.*

Key words : *Diagnostic radiology, Radiation protection, Entrance surface dose.*

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เหตุผลการทำวิจัย : *ในปี 1995 ทบวงการพลังงานปรมาณูระหว่างประเทศได้วางรูปแบบโครงการวิจัยเพื่อศึกษาค่าปริมาณรังสีในงานรังสีวินิจฉัยในประเทศทางแถบเอเชียและตะวันออกไกล ทบวงการฯหวังจะลดค่าปริมาณรังสีแก่ประชากร และได้ให้เงินสนับสนุนแก่ประเทศไทยเพื่อทำโครงการวิจัยนี้*

วัตถุประสงค์ : *ตรวจวัดค่าปริมาณรังสีที่ผิวของผู้ใหญ่ผู้มารับการถ่ายภาพเอกซเรย์ทั่วไปเจ็ดประเภทในสี่โรงพยาบาล และเปรียบเทียบกับ ค่าปริมาณรังสีที่คณะกรรมาธิการของประชากรยุโรปแนะนำไว้*

สถานที่ที่ทำการศึกษา : *แผนกวิชารังสีวิทยา โรงพยาบาลจุฬาลงกรณ์ โรงพยาบาลรามาธิบดี โรงพยาบาลศิริราช และโรงพยาบาลนครปฐม*

รูปแบบการวิจัย : *การศึกษาย้อนหลัง*

ผู้ป่วยที่ได้ทำการศึกษา : *การศึกษานี้ได้เลือกวัดปริมาณรังสีในผู้ป่วยจำนวน 280 คน ซึ่งมีน้ำหนักอยู่ระหว่าง 55-75 กิโลกรัม และรับการถ่ายภาพเอกซเรย์ 7 ประเภท โดยใช้ผู้ป่วยจำนวน 10 คนต่อประเภทต่อโรงพยาบาล*

วิธีการศึกษาวัดผล : *ทำการวัดปริมาณรังสีที่ผิวของผู้ป่วยด้วยตัววัดรังสีประเภทเรืองแสงเมื่อได้รับความร้อน ตัววัดและครื่องอ่านความเข้มของแสงจะต้องได้รับการปรับและเปรียบเทียบกับห้องปฏิบัติการ ระดับปฐมภูมิเพื่อความแม่นยำของการวัด*

ผลการศึกษา : *ค่าปริมาณรังสีที่ผิวของผู้ป่วยโดยเฉลี่ยเมื่อถ่ายภาพเอกซเรย์ปอดท่าหลัง-หน้า = 0.26±0.14 มิลลิเกรย์ ปอดด้านข้าง = 0.97±0.48 มิลลิเกรย์ กระดูกสันหลังท่าหน้า-หลัง = 2.81±2.09 มิลลิเกรย์ กระดูกสันหลังด้านข้าง = 7.97±5.32 มิลลิเกรย์ กระโหลกศีรษะท่าหลัง-หน้า = 1.37±0.8 มิลลิเกรย์ กระโหลกศีรษะด้านข้าง = 1.09±0.65 มิลลิเกรย์ กระดูกเชิงกราน = 1.59±1.08 มิลลิเกรย์*

วิจารณ์และสรุป : *ค่าปริมาณรังสีที่ผิวของผู้ป่วยต่ำกว่าค่าปริมาณรังสีที่คณะกรรมาธิการของประชากรยุโรปแนะนำไว้ อย่างไรก็ตามยังสามารถลดค่าปริมาณรังสีลงได้อีกโดยผลงานยังคงที่*

In October, 1995 a project to monitor radiation doses was initiated in Thailand with the purpose of protection from unnecessary exposure to radiation during general x-ray examinations. It was a retrospective study before the initiation of quality assurance programmes in radiology departments intended to reduce patient doses.[1,2] The Radiation Protection Service of the Ministry of Public Health participated in this research project by conducting quality control of the x-ray machines and other equipment. The medical physicists gave the radiographers advice and assistance in monitoring the patients' entrance surface doses for seven types of x-ray examinations. The effective dose can be estimated by the entrance surface dose using the X' dose programme developed by the National Radiation Laboratory of New Zealand.[3] The objectives of the current study were dose assessment for comparison with those recommended by the Commission of the European Communities.

This report describes 280 patients dose assessments from four institutes: Chulalongkorn Hospital, Nakornpathom Hospital, Ramathibodi Hospital and Siriraj Hospital. The results were finalized in June 1996.

Materials and Methods

1. Number and choice of patients

The average value of the doses measured for a representative sample of ten patients per type of examination per hospital should provide a good indication of typical clinical practice.[4] Patients with individual weights within 55-75 kg had been shown to be typical for an adult patient in Asia (IAEA recommentation).[5] Therefore, only patients within this weight range were selected. Dose measurements were made on seven types of radiographs ie. chest (PA, lateral), lumbar spine (AP lateral), skull (PA, lateral) and pelvis (AP). Patients who had difficulty in normal positioning were not included in the sample population.

2. Choice of dosemeter

Two hundred thermoluminescent dosemeters (TLD-100) were determined to be suitable for our examinations. These are small chips, enabling them to be stuck directly to the patient's skin. They can measure entrance surface dose and radiation back scattered from the patient per radiograph with high accuracy.[6] The National Radiation Laboratory of New Zealand had calibrated them for x-ray tube potential in the range of 60-100 kilovolts. The technical characteristics of the TLD system are shown in Table 1.

3. Practical techniques of measurement

Three calibrated TLDs packaged in an plastic sachet were adhered directly to the patient's skin with adhesive tape at the point where the central axis of the x-ray beam would enter the patient. The TLDs measured the entrance surface dose for each radiograph without exposing the same TLD more than once. Details of the exposure were compiled by the radiographer for each patient on a form show in Figure 1. These forms provided all the necessary information for

Table 1. Technical characteristics of the TLD system.

TLD reader	Harshaw 5500
TL material	LiF-100 (ribbon)
%SD of batch	3.81
Annealing procedure	400°C/1h + 100°C/2h
Reading process	T_{max} = 300°C; time= 20 sec; N_2 flow
Reading period after exposure	1 -15 days
Calibration after each annealing procedure	yes
Source used for calibration	Co-60
Cleaning process	none

Patient Dosimetry : Entrance Surface Dose Measurement

Hospital....C..... Room.....6..... Machine..... Villa.....

Examination ....Chest.... Projection....PA.... Film/screen class....400(Fuji/Lanex)....

Patient number	Age (y)	Sex	Weight (kg)	KV	mAs	grid	FFD (cm)	FSD (cm)	film size (cm)	TLD number	ESD (mGy)
3384/39	66	M	55	63	9	y	180	156	35x43	20009	0.137
123226/36	42	F	70	70	8	y	180	156	35x43	10012	0.257

Figure 1. The exposure form and examples for entrance surface dose measurement filled in by a radiographer.

the TLD laboratory to convert the TLD reading into absorbed dose outcome and for the doses to be analysed. If a radiograph was rejected after a dose measurement had been made, the reason for rejection was noted.

It was essential that all other TLDs not being used for a particular measurement were not left unshielded in the x-ray room during exposures.

Results

The average entrance surface dose per radiograph classified by type of examination measured at the four hospitals were within the dose limits recommended by the Commission of the European Communities (CEC) as shown in table 2. Techniques of taking radiographs are listed in the four columns on the right hand side. The x-ray tube potential used for radiography

Table 2. The average entrance surface dose per radiograph as measured at the four hospitals, classified by type of examination, sample size = 40 (For comparison with doses recommended by the Commission of the European Communities).

Examination	Av. surface dose (mGy)		X-ray technique			
			kV		mAs	
	Thai	CEC	Thai	CEC	Thai	CEC
Chest PA	0.26 ± 0.14	0.3	60-80	125	3-20	<4
Chest Lat.	0.97 ± 0.48	1.5	60-85	125	10-40	<8
Lumbar spine						
AP	2.81 ± 2.09	10.0	60-85	70-90	16-65	<80
Lat.	7.97 ± 5.32	30.0	70-96	80-95	36-150	<200
Pelvis AP	1.59 ± 1.08	10.0	60-85	75-90	6-48	<80
Skull PA	1.37 ± 0.8	5.0	60-75	70-85	16-50	<10
Skull Lat.	1.09 ± 0.65	3.0	58-73	70-85	8-40	<10

was less than that recommended by the CEC due the smaller size, and correspondingly less thickness, of the average Thai patient. However, the exposure in units of mAs recommended by the CEC were lower than the mAs used in Thailand.

Discussion

The standard deviation of the average entrance skin dose was high due to the variation of film-screen combinations used in the different institutes. However, the mAs exceeded the CEC recommendation. The medical physicist should try to make patient's dose as low as possible while maintaining the quality of images.[7] Martin C.J. achieved a programe of dose reduction by increasing tube potential.[8] A quality assurance programme should be instituted in order to provide diagnostic information at the least possible cost but with the least possible exposure. Low levels of effective dose[3] means low radiation risks for the patient.

Conclusions

The average entrance surface dose per radiograph measured as typical for Thai people was quite lower than that recommened by the CEC. The lowest entrance skin doses occurred when applying a high kVp and low mAs technique including use of a high speed film-screen combination of fast film and a rare earth screen. Minimizing incorrect exposure settings also reduced entrance skin doses. The launching of a

quality assurance program is neceesary for dose reduction for the general population.

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