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Assessment of skin radiation exposure for pediatrics examined by routine X-ray

تقييم التعرض الإشعاعي لجلد الأطفال المفحوصين بالأشعة السينية الروتينية

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Abstract

Assessment of radiation exposure during X-ray examination are of great importance in radiation protection field .Pediatrics radiology should be governed with high professionals techniques to minimize radiation hazard on children while they are examined by X-ray. The parameters which involved in this project are ,X-ray tube voltage, X-ray tube current and the distance between the X-ray tube and patient's skin(child).Different radiographic examinations representing different radiographic techniques (tube voltage and current)were recorded reflecting the variety in the radiation exposure value. computer program was used to calculate the entrance skin exposure .The results show that the radiation exposure was still below the value of risk at this time of exposure(ranging between 0.04-0.14 sec.).

الخلاصة

تقييم التعرض للإشعاع خلال الفحص بالأشعة السينية له أهمية كبيرة في حقل الوقاية من الإشعاع. يجب إن تكون عملية التصوير ألإشعاعي للأطفال محكمة بتقنية عالية لتقليل خطورة الأشعة على الأطفال إثناء الفحص ألاشعاعي.المعلمات الداخلة في هذا البحث هي ، الفولتية المسلطة على أنبوبة الأشعة السينية ، التيار المسلط على أنبوبة الأشعة والمسافة بين أنبوبة الأشعة السينية وجلد المريض (الطفل) . تم تسجيل فحوصات شعاعيه مختلفة و بمختلف التكنيكات الإشعاعية (التيار و الفولتية المسلطة على أنبوبة الأشعة السينية) مما يعكس الاختلاف في قيمة التعرض الإشعاعي . تم استخدام برنامج حاسوبي لحساب مدى تعرض الإشعاع الداخل للجلد. أوضحت النتائج الحالية بأن تعرض الإشعاع كان دون مستوى الخطورة في مثل هذا الفترات الزمنية للتعرض(بمدى من (0.04- 0.14 ثانية).

Introduction

There is an increasing interest in investigating the methods to reduce the dose received by the population due to medical exposure, in line with the directives of Health Protection laws. For diagnostic radiological examinations the basic concept is optimization, in order to use the minimum necessary dose to achieve a good image quality[1].

Exposure is defined strictly for air as the interacting medium. However, the term entrance skin exposure is frequently used in comparing techniques for various radiological procedures, and it refers to the exposure at the location in space at which the central ray of the radiation beam enters the patient. Entrance skin exposure is not equivalent to entrance skin dose, because it does not include the contributions from radiation scattered within the patient. It is, however, a quantity that can be easily measured and compared among facilities.[2].

The knowledge of the absorbed doses in tissues is a vital aspect of any radiological procedure, since doses define the potential risk of treatment. In addition, diagnostic radiology is the main source of exposure of the population to man-made ionizing radiation. On the other hand, typical doses from diagnostic radiological exams are usually small and do not approach thresholds for deterministic effects[3].

However, there has been a growing concern among the general public, as well as the scientific and medical communities regarding the risks of radiation exposure from diagnostic X-ray examinations.1 It is recognized that the risk of children developing radiation-induced malignancies is two to three times higher than that of adults. Since patients benefit from radiological examinations, the radiation risk involved has always been considered to be acceptable. With the advent of improved imaging techniques such as digital radiography, there has been a potential for reducing radiation dose to patients whilst obtaining adequate image quality.[4].

Several authors have also investigated doses received by children. As children are at a greater risk of suffering detrimental effects from exposure to ionizing radiation than adults, it is important that the radiation dose arising from diagnostic medical exposure be minimized [5].

Since radiation measurement devices can't be put just under the skin of patients undergoing x-ray exams, we are used a radiation instrument with a "phantom" (a plastic sphere or square to represent a body) in the beam to estimate entrance skin exposure dose for various exams as shown in fig.(1).

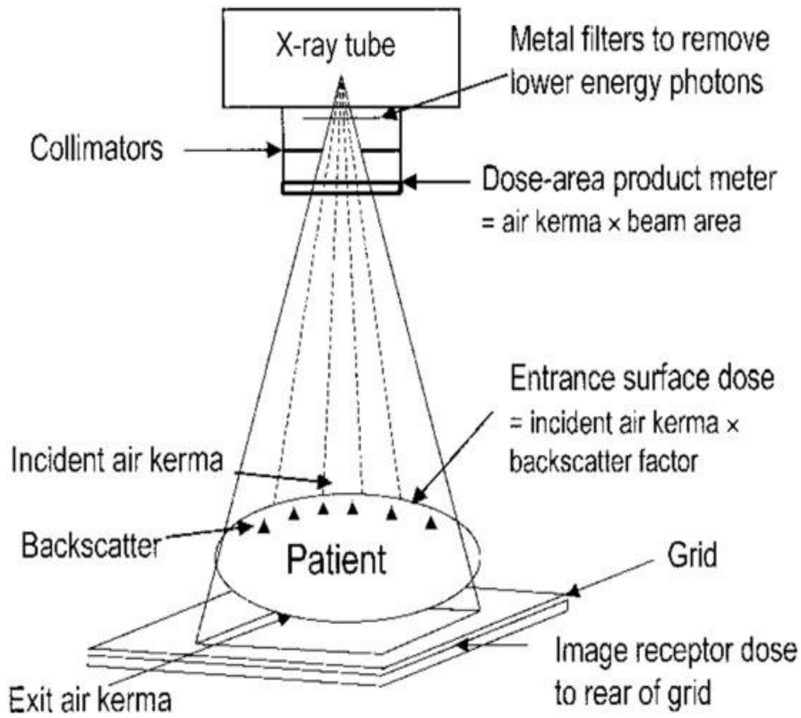


Fig.(1): . Diagrammatic representation of a radiographic unit, showing the positions where the various dose quantities occur and where they would be measured.

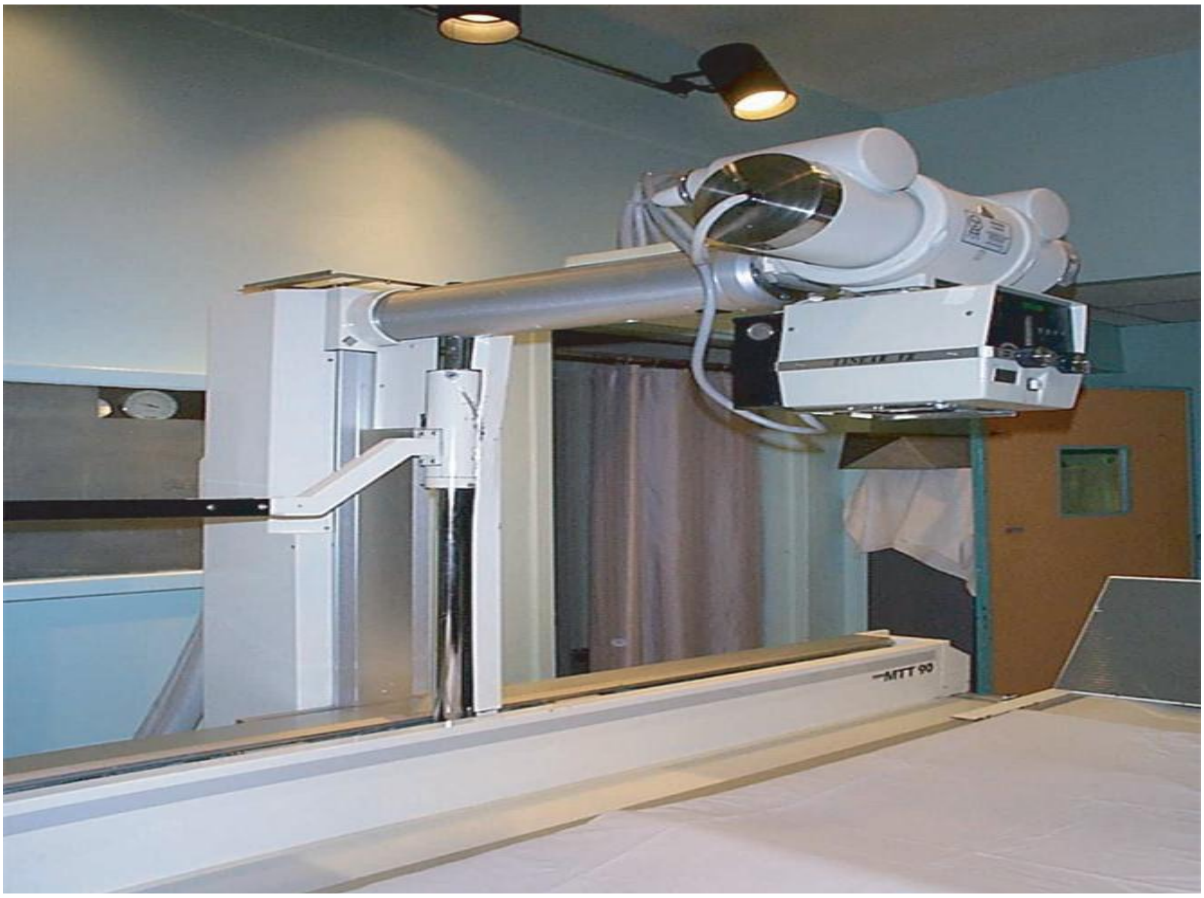
The radiation instrument is placed on the phantom to catch the x rays just as they enter the phantom. The instrument result is actually an exposure-in-air measurement and we measured it to estimate skin dose and to calculate organ doses (for organs that lie in the x-ray path). The entrance skin exposure ESE) was measured in units of Roentgen (R) or milliRoentgen (mR)[6].

Children have higher radiosensitivity than adults mainly because of their longer life expectancy. It has been estimated that radiation exposure in the first 10 years of life has an attributable lifetime risk (for certain detrimental effects) three to four times greater when compared with exposures between the ages of 30 and 40 y and five to seven times greater when compared with exposures after the age of 50 y[7].

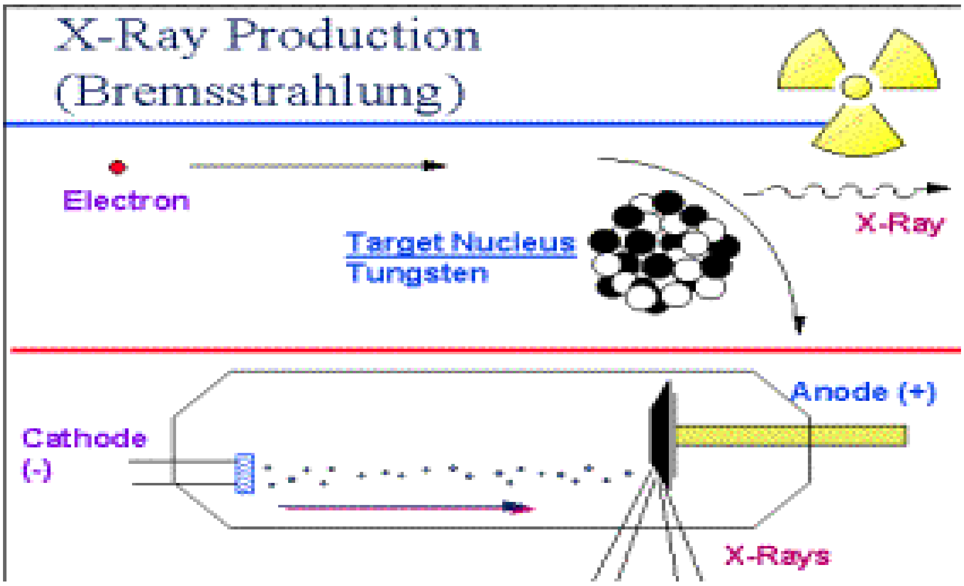
Material and method:

To identify X-ray radiation it must be suit the different body's sizes , different radiographic examinations (X-ray positions) were recorded in this project and these data were collected from experience radiographer of 25 years working in radiography in Al-Sadder teaching hospital, filter of the X-ray tube was made of Aluminum(Al) with 3mm thickness (used in software)and the distance between the X-ray tube and patients are approximately 80cm except for chest X-ray taken 180 cm for technical cause (used in software). Age of children in this project ranging from(2 to 7 years)

In order to increase the speed and efficiency of the patients dosimetery process , a windows based computer program ,called Pad Pro software was used in this study .This software has gained popularity with many other nuclear professionals in medical engineering, medical physics and other nuclear physics disciplines. The x-ray machine/device calculator allows the choice of empirical data or the use of known x-ray tube output. Software developed by Ray Mc Ginnis ,last update Augst,6,2007.[8].



Fig(2): A photograph for the X-ray instrument used in radiography(routine)



Fig(3): Schematic diagram showing the process of production of X-ray inside the X-ray tube(simply) .

Results

Table(1): The results were tabulated as following:

No	X-Ray Examination	Tube voltage (volt)	Tube current (mA)	Time of exposure (sec.)	Entrance skin exposure(mR/time of exposure)
1	Hand (AP)	42.5	100	0.040	8.3066
2	Hand (Lateral)	47	100	0.040	11.809
3	Wrist (AP)	43	100	0.050	13.353
4	Wrist (Lateral)	45	100	0.050	15.275
5	Forearm (AP)	50	100	0.050	20.080
6	Forearm (Lateral)	55	100	0.064	32.870
7	Elbow joint (Lateral)	68	100	0.064	5.1580
8	Elbow joint (APl)	56	100	0.064	1.4250
9	Arm (AP)	55	100	0.074	38.013
10	Shoulder joint (AP)	60	100	0.064	40.023
11	Skull (AP)	60	100	0.100	62.537
12	Skull Lateral)	57	100	0.110	4.8998
13	Neck ((lateral)	50	100	0.100	40.178
14	Chest (AP)*	68	200	0.100	3.1730
15	Chest (lateral)	65	200	0.120	88.468
16	Abdomen (AP)	70	100	0.120	104.60
17	Abdomen (lateral)	65	200	0.130	95.862
18	Pelvis (AP)	62	100	0.800	35.644
19	Pelvis (Frog leg)	65	100	0.800	589.79
20	Knee joint (AP)	55	100	0.070	35.958
21	Knee joint (Lateral)	55	100	0.065	33.390
22	Femur (AP)	60	100	0.064	40.023
23	Leg (AP)	52	100	0.063	2.8136
24	Leg (lateral)	54	100	0.066	5.8964
25	Ankle (AP)	55	100	0.050	25.684
26	Foot (AP)	50	100	0.040	16.041
27	Foot (lateral)	50	100	0.045	18.080
28	Skull post nasal space	55	100	0.140	71.917

*Distance between X-ray tube and skin of the children was (72 inch corresponding 180 cm)

***PA(posterior Anterior):** refer to radiographic position in which the front face of part of the body want to be examine by X-ray must attach to X-ray film and the back face of same part must facing X-ray tube

*AP(Anterior Posterior): refer to radiographic position in which the back face of part of the body want to be examine by X-ray must attach to X-ray film and the front face of same part must facing X-ray tube.

*For comparison purpose we list a table mention the upper limit(as general as) for entrance skin exposure for adult(age from 15 years and up) [9].

No.	Examination(projections)	Recommended Upper Limits Skin exposure	
		mR	C/Kg
	Chest (P/A)	20	5.2
	Skull (Lateral)	224	224
	Abdomen (A/P)	627	162.0
	Cervical Spine (A/P)	137	35.0
	Thoracic Spine (A/P)	380	98.0
	Full Spine (A/P)	263	68.0

Discussion

Entrance dose and effective dose was measured by [12] for adults using TLD doismeter recording the same radiographic examinations using tube filter thickness 3 mm : Al .

Measurement of the radiation exposure from typical survey CT(computed tomography) scans, to compare their exposure to that of typical chest radiographs, and to explore methods for radiation exposure reduction, had entrance skin exposure values range from(3.2 mR to 74.7 mR)[13].

It is necessary to keep the exposure doses from X-ray examinations as low as is reasonably achievable to avoid radiation skin injuries in patients undergoing radiographic examinations. Entrance skin exposure was calculated in(mR) relative to the time of exposure that mentioned in table **(1).**

Our observations show that the entrance skin exposure value had affected significantly with both the time of exposure and greatly with tube voltage (KV) more than the tube current (mA) because penetratability of the X-ray depend on the amount of energy that the photon carry it

Our results were comparable with [5] who estimate the entrance skin dose ,but in unit of (μGy) using TLD dosimeters (practical work) using tube filter (Al: range from 2.7-3.2 mm thickness) , for example the dose for skull(AP) was 632 μGy that corresponding to 71mR and for pelvis the dose was 347 μGy that corresponding to 39.8 mR, and if there is a small variation , it is due to the variation in tube voltages(±5) .

Our work(idea of the project) was similar to work published recently that which concerned to estimating surface dose ,but for adult patients who are examined by routine X-ray examination, our results were lower than the results of such project due to the high X-ray tube voltage.[10], where the dose for example to hand was 0.25mGy that corresponding to 28 mR while the dose calculated by this project was 8.306mR. .

Other work also done for estimating pediatrics dose using phantom of different size even using different X-ray technique(mA and Kv) ,this project measure entrance dose by TLD dosimeters ,the time of exposure was comparable to our time of exposure considered in this project as shown in table(2)[11]

Table 2:
Technical parameters used in the simulated radiographs with thoraces of children phantoms

Age (years)	Tube voltage(KV)	Tube current time product(mA s)	Tube current(mA)	Time(sec.)
2	52	8	320	0.025
6	56	16	320	0.050
10	62	14	320	0.075

Conclusions:

1.Presented data may be used to determine patient(paediatrics) exposure from routine X-ray examinations.

2.The results of this study showed high exposure levels relative to the time to which the patient are exposed to the X-ray .

3.It was observed that there was a wide variation in patient dose that reflect different radiographic techniques(tube voltage and tube currents).

4.It was seen that for the successful outcome of any optimization effort, the mutual understanding and close cooperation of medical physicists with operators and radiologists is mandatory.

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