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Research Article

Diagnostic Reference Levels of Radiation Dose for Pediatric Patients in Khartoum State Hospitals

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Abstract: The purpose of this study is to determine diagnostic reference level for children through entrance surface dose (ESD) calculations. Radiation doses received by 790 pediatrics patients, during routine x-ray examination, at departments of diagnostic radiology in five hospitals in Khartoum state, were calculated. Patients are classified into four age groups, 0-> 1year, 1-> 5 years, 5-> 10 years and 10->15 years old. The X-ray tube output for each equipment was measured using calibrated ionization chamber (RAD – Check Plus model 06-526). Variation was found in values of ESD from hospital to another, these variations were due to difference in settings of the exposure factors to each patient, also to the difference of output of machines. Results were compared with the international diagnostic reference levels and they were greater than the international diagnostic reference levels.
Keywords: diagnostic reference, x-ray examination, Khartoum

INTRODUCTION

Radiation dose to patients from diagnostic imaging procedures is an important issue. Of the medical uses of radiation, the examination of patients with x-rays for diagnostic purposes is by far the most frequent practice. Doses from diagnostic x-ray examination in general are relatively low [1]. X-ray examination may be of great benefit but they also of slight risk. Risk of determination radiation effects are higher for pediatric patients than for adults (stem cells are radiosensitive. the more mature a cell is, the more resistant to radiation it is .The younger tissues and organs are, the more radiosensitive they are [2]. Therefor, it is particularly important to insure that radiation doses for pediatric radiology were kept as low as possible and closer attention should be done to improve the diagnostic information, reducing the child's dose as much as possible, according to ALARA principle [3, 4]. Patients undergoing x-ray examination are subjected to a wide range of exposure levels. Sources of exposure that must be shielded in diagnostic x-ray room are primary radiation, scattered radiation, and leakage radiation. Scattered and leakage radiations together are called secondary or stray radiation. Primary radiation, also called the useful beam, is the radiation passing through the open area defined by the collimator of the x-ray tube [5, 6].The amount of primary radiation depends on the output of the x-ray tube per examination, scattered radiation arises from the interaction of the useful beam with the patient, causing a portion of the primary x-ray to be redirected [7]. Dose to tissues and organs from medical radiation exposures are evaluated in term of absorbed dose, which is defined as the mean energy transferred by radiation to for x-ray examination, the dose without backscattered at the entrance side of the patient is specified by the air kerma. The effect of backscatter is included in specification of entrance surface dose, which is defined as the dose to the first 1 cm of tissue [8]. Doses received by a patient in x-ray examination are function of imaging modality and technique [8]. Radiation protection is an important concept in diagnostic radiology. The most important consideration in protecting the patient is to ensure that images of sufficient quality for accurate diagnosis are produced without the need for any repeat [9]. The means to achieve this are the design and maintenance of equipment, training and experience of staff, robust operating procedures [9]. Patients can undoubtedly obtain enormous benefit from diagnostic X-ray examinations, although the ionizing nature of the X-rays means that their use is not entirely without risks. For this reason, all exposures to diagnostic X-rays need to be justified and optimized in terms of benefit and risk [10]. One of the basic requirements for such requirement is the knowledge of patient doses.

MATERIALS AND METHODS

Data had been collected in a period of 6 months at radiology departments in five hospitals in Khartoum state. Entrance surface dose (ESD) for each examination was calculated from exposure factors recorded at the time of examination, using computer software called Dose Cal which is designed for both adults and children data. This software was developed by radiological protection center of Saint Gorge's hospital, London. ESD were determined Tube output of all x-ray machines used in this study was measured using calibrated ionization chamber (RAD – Check Plus model 06-526).

RESULTS

Distribution of studied group according to hospital and examination are shown in table 1.

Distribution of studied group according to age and sex are shown in table 2

Number of patient underwent all examinations according to sex are distributed in table 3.

Table 4 gives a summary of minimum, maximum and average dose in (mGy) for each examination comparing with world reference levels for diagnostic.

Table 1: Distribution of studied group according to hospital and examination

Exam	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Total
Chest	153	82	75	64	62	436
Skull	12	11	09	08	09	49
Abdomen	15	19	11	12	10	67
Shoulder	07	13	06	07	03	36
Pelvis	07	14	08	08	09	46
Wrist	11	13	06	05	13	48
Upper limps	12	10	18	08	10	58
Lower limps	10	13	10	08	09	50
Total	227	175	143	120	125	790

Table 2: Age group and number of patient for each sex

Age Group	Female	Male	Total
0 > 1	54	60	114
1 > 5	171	213	384
5 > 10	68	104	172
10 > 15	55	65	120
Total	348	442	790

Table 3: Distribution of studied group according to sex and examination all exams

Exam	Female	Male	Total
Chest	200	236	436
Skull	15	034	49
Abd0men	28	039	67
Shoulder	21	015	36
Pelvis	16	030	46
Wrist	21	027	48
Upper limps	28	030	58
Lower limps	19	031	50
Total	348	442	790

Table 4: A summary of minimum, maximum and average dose in (mGy)

Examination	Maximum	Minimum	Average	Reference
Chest	3.490	0.200	0.660	0.400
Skull	5.700	0.750	1.400	1.00
Abd0men	5.472	0.368	1.294	1.00
Shoulder	7.674	0.500	1.242	0.600
Pelvis	5.12	0.95	1.246	0.400
Wrist	3.256	0.456	1.436	0.800
Upper limps	3.066	0.402	1.640	0.770
Lower limps	3.104	0.42	1.532	0.770

DISCUSSION

From results obtained, variations in the values of entrance surface dose ESD from one hospital to another were observed. In addition, it is found that no regular quality control measurements were done to those hospitals. These variations were due to the difference in setup from one hospital to another for the same exam also due to the exposure factors used [Kv, mAs, field size], and also to difference in X-ray output from one hospital to another. To justify the difference the effect of exposure factor and patient size and field size must be considered. Also it is found that in each hospital the values of ESD were higher than the value of the reference levels for diagnostic.

CONCLUSIONS

According to this study, we found that:

- Doses vary from machine to machine though Kv and mAs settings do not vary very much from machine to another, it is clear that the difference in doses is a result of either: Difference between settings and actual radiation energy and flux, Filtration, Scattering from the too large fields, performance of equipment's and processors, Radiographic techniques used in each hospital, Film-screen combination, Use of grids. And training and skills of the staff.
- The irradiated area is sometimes twice as large as it should be; this is a result of not using radiation beam limiting diaphragms, if available.
- It was noted that, some facilities produce poor x- ray pictures resulting in retakes and unnecessary radiation exposure.
- All doses are found to be above the international recommended levels.
- The objective must be to keep exposures to the lowest level that is necessary by carefully justifying procedures and by improving techniques, instrumentation and practices.
- All modern x-ray machines have field limiting optical diaphragms. If there are not available, the use of cones and shielding of the nearby radiosensitive organs will definitely reduce scattered doses and should be mandatory.

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