ORIGINAL ARTICLE

Assessment of Radiation Dose in Routine X- Ray Examination of Skull, Chest and Abdomen of Children in Teaching Hospitals "Rapreen, Rizgary and Hawler" in Erbil

FATIHEEA FATIHALLA HASSAN [1*], NASHWAN KARKHI ABDULKAREEM[1], ILHAM KHALID IBRAHIM[1]
[1]Department of Basic Science- Biophysics Unit, College of Medicine, Hawler Medical University (HMU), KR, Iraq.
Correspondence to Fatiheea Fatihalla Hassan,Lecturer inDepartment of Basic Science- Biophysics Unit, College of Medicine, Hawler Medical University (HMU), KR, Iraq. Mobile: +964-7503148390, Email Address: fatiheea.fatihalla@hmu.edu.krd, or fatehiya64@yahoo.com

ABSTRACT
Background: The risk of exposure to ionizing radiation may affect children more than adults. Therefore, minimizing radiation exposure to pediatric patients should be measured when undergoing X-ray examination.
Aim:: To determine the limit of radiation doses to pediatric patients examined by routine X-ray in radiology departments of hospitals in Erbil, Iraq.
Methodology: The study was conducted on children patients, whose ages were <12 years, who underwent X-ray examination to the skull (AP), chest (AP), and abdomen (AP) in Erbil Hospitals. Entrance skin doses (ESD) delivered to pediatric patients in three Erbil hospitals had been monitored.
Results: Higher pediatric dose was not according to as Low As Reasonably Achievable (ALARA) standards. Radiation exposure was found to be higher to the skull (AP), chest (AP),and abdomen (AP), which is the most performed radiographic areas in pediatric patients. Consequently, there is a need to monitor radiation exposure to pediatric patients in Erbil hospitals.
Key words: Pediatrics,EntranceSkinDose,skull,chest,abdomen.

INTRODUCTION

Absorbed dose of X-ray emissions must be measured in relation to the dose level that may have harmful effects to pediatric patients (PP). Radiation protection in children requires a more cautious approach since they run a greater risk of long-term effects of radiation exposure in adulthood. Malignant tumors in growing organs and tissues, genetic mutations, and congenital abnormalities, may increase by higher radiation absorbed dose[1,2]..

Consequently, radiation protection international rules have been strictly applied in pediatric hospitals. These include justification, optimization and radiation doses that must be recorded to a range of reference dose according to a child's age[2].

Radiation dosage especially in children must take into account several factors. These include a child's weight, age, body mass index, voltage of X-ray equipment, current, distance between patient and X-ray source, screening time, equipment type, and processing performance[3].

It is incumbent that radiology departments apply entrance surface dose (ESD), reference dose levels (DRL) and effective dose calculations in PP. Furthermore, X-ray image quality should be improved without increase of radiation exposure to PP. This includes reduction in time exposure to ensure maximal protection to PP from ionizing gradiation sources[4].

Measurements of absorbed dose of radiation expresses the quality of energy that is absorbed, and how this may have harmful effects to human cells. Early life radiation exposure from X-ray equipment, CT scan, Ultrasound, and MRI increase lifetime risk for solid cancer, compared to adult patients.

This work was conducted Rapreen hospital, Rizgary hospital, and Hawler Teaching hospital. Currently, there is a lack of information on pediatric radiation dose, as well as, assessing the exposure parameter selected for X-ray pediatric procedures and estimating absorbed delivery dose to PP undergoing X-ray examinations at the aforementioned hospitals.

The results of this study put the dose reference level of pediatric in Kurdistan, as a practical tool to manager radiation dose from X-ray examinations in Erbil hospitals and used as a baseline for future work.

MATERIALSANDMETHODS

This study was conducted on PP<12 years of age who visited X-ray departments at three Erbil hospitals. Raprain Hospital is the only specialized hospital in Erbil for children X-ray examinations. Raprain Hospital does not have an ionizing radiation protection facility for PP.X-ray imaging doses studied were chest, skull, abdomen for anterior posterior (AP) projection. NOMEXMUILTIMETER were measured for each PP during the X-ray imaging performed, kilo voltage peak (Kvp), product of tube current, time (mAs), and focus film distance (FFD).

A total of 110 children were included in this study. The output of X-ray tube 70KvP, 5m Asand X-ray sources 60 cm were measured by NOMEX MUILTIMETER which is calibrated by PTW. The entrance surface dose for pediatric patients was calculated by following equation:

ESD=(O/P) X (KVP/70)2 X (mAs) X (60/FSD)2 X (BSF)

(O/P) is the tube output mGy/m As measured at a distance of 60 cm from the tube focus along the beam axis.

O/P=Average NOMEX Reading mGy/tube current time product (mAs)=mGy/mAs

While kVp: is peak tube, mAs: is the tube current, time product whereas FSD: is the focus-to-patient entrance surface distance, and BSF: is the backscatter factor. The BSF used was 1.35[13].

O/P=Average NOMEX Reading/tube current time product (mAs)=mGy/mAs. The dose measured of this study was comparable with international level of pediatric doses and previous studies on pediatric exposure to X- ray radiation[14,15,16]

RESULTS

Table 2 indicates the mean and standard deviation for ages, weight, voltage, and current product. X-ray to chest is the most frequently performed area in Erbil hospitals, followed by skull X-ray. The mean tube voltage increased with age of children as seen in table (2). Minimum mean voltage used for PP was 50kVp, while maximum mean voltage was 80 kVp .Minimum As for all ages was 5mAs while maximum meanvaluewas15mAs.Itwasshownthatcurrentproductincreaseswith ageof patient for the skull, chest and abdomen examinations. Anterior posterior X-ray examinations were conducted on skull, chest and abdomen.

Technical parameters used for each PP were kilovoltage (kVp), product of tube current (mAs) while total filtration was measured by NOMEX MUILTIMETER. Distance was measured between patient and X- ray tubein(cm).

A total of 110 PP were included in this study. Only acceptable diagnostic images were used. The X-ray machines used in Erbil hospitals was manufactured in the year 2005 by Shimadzu Corporation.

Table1: PP classification according to gender, age

Gendergroup		Agegroup		
Boys	Girls	1-4	5-9	10-12
56	64	30	40	50

Table 2: PP data and radiographic parameters for X-ray examinations in Erbil hospitals (Rapreen, Rizgary, and Hawler Teaching Hospitals)

Ageyear	Weight(kg)	kVp	mAs	FFDcm
1-4	11.86±1.35	55±1.32	5±1.32	75
5-9	19.51±1.12	60±1.67	7±1.67	70
10-12	27.31±1.54	70±1.36	9±1.42	65

Table 3: the mean Entrance Skin Dose (ESD)(mGy) was measured for skull (AP), chest (AP) and abdomen (AP) for age groups1-4years,5-9 years, and 10-12 years.

Typeof Examination	Ageyear	Rapreen Hospital	Rizgary Hospital	Hawler Teaching Hospital
SkullAP	1-4	2.84	3.24	3.93
	5-9	4.67	4.71	5.37
	10-12	6.02	7.65	8.26
ChestAP	1-4	2.28	2.72	3.57
	5-9	2.64	3.63	4.33
	10-12	3.83	4.17	4.89
AbdomenAP	1-4	5.93	4.18	5.53
	5-9	8.84	5.45	9.78
	10-12	11.74	12.57	15.4

Table 4: Descriptive Statistics ES values and range obtained for PP in Erbil hospitals

Age(year)	Skull(AP)	Chest(AP)	Abdomen(AP)
1-4	3.34±0.5 (6.03-11.32)	2.86±0.65 (1.19-3.32)	5.21±0.91 (11.03-13.28)
5-9	4.92±0.3 (8.98-10.91)	3.53±0.84 (4.02-6.93)	8.02±2.27 (20.27-23.18)
10-12	7.31±1.15 (13.26-15.73)	4.29±0.54 (7.18-8.56)	13.24±1.9 (12.31-14.72)

Table 5: Comparison of the mean ESD(mGy) obtained in this study with international published literature and reference dose values

TypeofExamination	Ageyear	PresentStudy	Ethiopia	Brazil	D
SkullAP	1-4	3.34	4.76	1.603	1.100
	5-9	4.92	6.55	2.041	1.100
	10-12	731	11.97	2.554	1.100
ChestAP	1-4	2.86	1.72	0.125	0.70
	5-9	3.53	3.40	0.146	0.079
	10-12	4.29	5.87	-	-
Abdomen AP	1-4	5.21	10.26	0.714	0.500
	5-9	8.02	14.30	1.238	0.800
	10-12	13.24	11.12	1.205	1.200

PP in age group 1-4 years received the lowest mean ESD of radiation 6.52mGy in the chest and highest mean ESDof16.27mGyin the skull for PP in age group 10-12 years. Comparison of mean ESD of this study with previous studies conducted in Ethiopia[14], Brazil[13] and International Reference Dose (IRD) is shown in Table (5). The mean ESD in this work for skull (AP), chest (AP),and abdomen (AP) was higher than the doses published in previous studies conducted in Ethiopia andBrazil, including IRD levels For abdomen examination the highest mean ESD was found Ethiopian hospitals than this study for the age group[10-12]. Table 3: The mean Entrance Dose (EDS) mGy result with Rapreen, Rizgary, and Hawler Teaching Hospitals

DISCUSSION

In this study, 110PP (ages from 1-12) years were examined by X-ray in radiology department sat Rapreen hospital, Rizgary hospital, and Hawler Teaching hospital. ESDofX-ray were calculated for skull (AP), chest(AP), and abdomen(AP) (see Table 1). Tube voltage increased with the age group of PP as shown in Table (2). On this note, the European Commission (10) recommended the tube voltage for PP to be in the range of (60–80) kVp for ages(0–1) year, and(100–120)kVp for ages (5–12) years.

The European Commission also reported avoid low voltage use for children less than 60kVp. In Erbil hospitals the mean tube voltage (kVp) and tube current loading (mAs) are based on high tube potential. Moreover, a high tube current is used for all pediatric group ages examinations.

Radiograph operators use tube voltage of (55–60)kVp for PPs (1-5) years age group and (60–90)kVp for (5–12) years age group.

These potential values are much higher than the recommended values by the European Commission and other previous studies on PP in Ethiopia and Brazil. This Based on our results we conclude that radiographers at Erbil hospitals must be mindful when calculating the ESD in order to protect PP(7), that need special attention and spread radiological units[8,9]. Current loading (mAs)
Increase in all hospitals with increasing pediatric age for different examinations.

As the focus distance between PP and X-ray tube was very small (50–75)cm were used instead of 180cm as recommended by CEC[10].The distance between patient and X-ray tube is crucial important since the inverse proportional between square distance, higher pediatric dose has been reaching the patient. It is there of re-essential to safeguard

PP from unnecessary radiation exposure by increasing the focus distance to lower the ESD pediatric.

Technical factors such as voltage, current loading, and focus distance were used increase the ESD to the patient[11].

Generally, the inadequate training of imaging staff, use of different types of equipment, and various technical factors that used at the Erbil hospitals informed the dose outcome to PP.

Our study revealed that the mean ESD in Erbil hospitals was higher than IRD recommendations and previous studies[5,14.15].

CONCLUSION

In Kurdistan, there are several medical X-ray units at hospitals and clinics. Unfortunately, there is a lack of health centers for diagnostic X-ray do not have standard radiographic techniques, exposure parameters, and International reference dose (IRD) including pediatric ages that are appropriate or children.

Our study results were found to be higher in all projections, which is most performed radiograph in Erbil hospitals. The mean entrance doses when compared to Ethiopian and Brazilian entrance doses were higher.This meansthat both PP and radiographic operators are exposed to a higher radiation risk at Erbil hospitals. Incorrect use of voltage and mAs and should be maintained dose also was achieved (ALARA) principles to minimize the dose and the risks.

Finally, pediatric radiology units should be separated since children need best protection.

Ethical Approval: Ethical approval was obtained from the Research Ethics Committee of the College of Medicine, Hawler Medical University, meeting Code:8, Paper Code: 10, Date 13/10/2019

REFERENCES

1. Muhogora WE, Nyanda AM. The potential for reduction of radiation doses to patients undergoing some common X-ray examinations in Tanzania. RadiatProt.Dosim.:2001, 94:381–384.
2. ICRP, Radiological protection in paediatric diagnostic and interventional radiology. Annals of the ICRP,2011;48393982-4649.
3. Bushberg JT, Seibert JA, Leiholdt EM, Boone JM. The Essential Physics of Medical Imaging.2nd ed. Philadelphia, Pa: Lippincott& Wilkins, 2002;14:11-24.
4. United Nations Scientific Committee on the Effects of Atomic Radiation Sources. Effects and Risks of Ionizing Radiation. UNSCEAR Report,Vol.II:effects.NewYork,2000.
5. Hart D, Wal IBF, Schrimpton PC, Bungay DR, Dance DR. Reference doses and patient size in pediatric radiology. National Radiation ProtectionBoard.Report-318. Chilton: HMSOm 2000.
6. International Commission for Radiological Protection Publication. The Recommendations of the International Commission on Radiological Protection. Publication103, Oxford and New York: Pergamon Press;2007.
7. Medical Imaging Center, University of Helsinki, Helsinki, Finland. Summary, Acta Radiologica,2009; 50(1)114-124.
8. NATIONAL RESEARCH COUNCIL, Improving Risk Communication, National Academy Press, Washington, DC.1989
9. Radiological parameters and radiation doses of patients undergoing abdomen, pelvis and lumbar spine X-ray examination sin three Nigerian hospitals, Radiation Protection Dosimetry (21). Advance Access published September 17, 2008, Radiation Protection Dosimetry (2008), pp.19doi:10.1093/rpd/ncn 23.
10. European guidelines on quality criteria for diagnostic radiographic images. Report EUR 16260. National protocol for patient dose measurements in diagnostic radiology. Report of the Working Party of the Institute of Physical Science in Medicine. Chilton Didcot, NRPB.1992.
11. European Commission. European Guidelines on Quality Criteriafor Diagnostic Radiographic Images in Paediatrics, EUR16261, EN, Luxembourg;1996.
12. Seifa Teferi, Daniel Adimase, Tekle Abate. Entrance surface dose Measurement in Pediatric Patients under-Going Common Diagnostic X-ray Examinations. Ethi. J. Heal & Dev, 2011;49:51.
13. Suliman II, Abbas N, Habbani FI. Entrance Surface Doses to Patients undergoing Selected Diagnostic X-ray Examinations in Sudan. Vol. 123.Oxford university press, 2006; pp. 209–214. [PubMed] [Google Scholar]
14. Olowookere CJ, Babalola IA, Olayiwola MO, Odina G, Obed RI, Bello TO. Comparison of Five Models for Assessing Patient Dose from Radiological Examinations. Afr J Med Phy Biomed Eng&Sc, 2009: 21–29. [Google Scholar]
15. Suliman II, Elshiekh HA. Radiation in paediatric X-ray examinations in Sudan. Rad Prot Dosim, 2008;132:64–72. [PubMed] [Google Scholar]
16. Mohammadain KE, Rossa LA, Zevedo CA, Gvebe IMR. Dose evaluation for pediatric chest examination in Braziland Sudan .Low doses and reliable examination scan be achieved in developing countries. J. Phys. Med. BIO, 2004; 49: 1017-10.