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Abstract

Protecting the gonads of children and adults is of particular importance during diagnostic imaging of the pelvis since evidence suggests that X-rays could cause direct damage to the gonad which could result in mutation. Gonad shielding during diagnostic X-ray procedures is an effective way of reducing dose to patients' reproductive organs and reduces the risk of genetic effects in future generations. Given the potential harmful effects associated with exposure to ionizing radiation, it is important not just to provide gonad shielding, but also to measure patient doses, and reduce them where possible. The aim of this study was to provide patient dose estimates for pelvic examination being undertaken at selected diagnostic centers in Ghana as a baseline data for pelvic dose optimization in Ghana. Dose measurements were calculated on 323 patients (137 (42%) male, 186 (58%) female, ages, 38.56 yr ± 9.0; range 20–68). The Entrance Surface Dose (ESD) was determined by an indirect method, using the patient's anatomical data and expo¬sure SDUDPHWHUV XWLOL]HG IRU WKH VSHFL¿F H[DPLQDWLRQ 7KH 4XDOLW\ $VVXUDQF by Integrated Radiological Services Ltd. in Liverpool, UK was used to generate the ESD values. There were variations in the technique factors used in all the centers as compared to the recommendations in the European Commission (& TXDOLW\ FULWHULD (LJKW\ SHUFHQW RI WKH KRVSLWDOV UHFRUGHG ORZHU reference levels (10 mGy) and 40% of the hospitals exceeded the UK national reference value (4 mGy). The varia¬tions in the data recorded demonstrate the importance of creating awareness by the radiographic staff on quality assurance and standardization of protocols to ensure satisfactory standards and optimized radiation dose to patients and staff.

Keywords: Gonadal dose; Patient dose assessment; Optimization

Introduction

Protecting the gonads of children and adults is of particular importance during diagnostic imaging of the pelvis since evidence suggests that X-rays could cause direct damage to the gonad which could result in mutation [1]. Gonad shielding during diagnostic X-ray procedures is an e ective way of reducing dose to patients' reproductive organs and reduces the risk of genetic e ects in future generations [2]. Given the potential harmful e ects associated with exposure to ionizing radiation, it is important not just to provide gonad shielding, but also to measure patient doses, and reduce them where possible.

e most reliable dosimetry quantities commonly used in diagnostic radiology to give an indication of the typical dose that is being delivered to an average adult patient are the patient Entrance Surface (skin) Dose (ESD) including backscatter for simple X-ray projections, and the Dose Area Product (DAP) for complex examinations [3,4]. e ESD, in particular, is recommended as the most appropriate dosimetry quantity for simple X-ray projections since it meets the three basic conditions set out by the International Atomic Energy Agency (simple to measure, permits direct measurement on patient during the examination, and is representative of the dose received by the patient). It is also recommended by the Commission of the European Communities (CEC) in the document on quality criteria for the most common radiographic images. In addition, the measurement of ESD permits easy comparison with published diagnostic guidance or reference levels [4-7].

Patient radiation protection in pelvis X-ray examination has not been given much attention in Ghana. erefore this study was set out to provide an estimate of patient dose in pelvic examination being undertaken at selected diagnostic centers in Ghana as a baseline data for pelvic dose optimization in Ghana. e estimated mean ESD values were compared with the International Atomic Energy Agency [6], the European Commission (EC) guidance on diagnostic reference levels for medical exposures [8], and the 2005 United Kingdom reviewed reference levels [9]. is comparison was felt to be appropriate because at the time of the study, there were no accepted local or national diagnostic level values in Ghana for comparison.

Materials and methods

Subjects

Patient Radiation dose assessment was conducted on 323 patients over 18 years, who underwent pelvic examinations during the study period. Inclusion criteria were patients over 18 years, who underwent pelvic examinations in ten selected diagnostic centers in Ghana from January to April, 2011. e pelvic examination was selected for this study because during this examination, critical organs (testes, ovaries) that contribute to e ective dose are irradiated. Data was collected on 323 patients who underwent Antero–Posterior (AP) pelvis examination in 10 selected hospitals. Ten radiographers and ten radiographic technicians participated in the study and completed the data collection sheets a er each examination. e data sheets required for the study were placed near the console of the X-ray room and were completed by the radiographers when a patient entered and required pelvic examination. e examination rooms were chosen for practical and logistical reasons, and were representative of the regional and district hospitals in Ghana. A tape measure of a least count of 0.1 cm was use

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to measure the Focus-Film-Distances (FFDs). All FFD measurements were from the centre of the tube to the lm or the table top.

0X-ray equipment

Table 1 shows the characteristics of the X-ray machines in the 10 hospitals used for the study, all of which were constant potential generator (80 kVp) with 2.5 mm Al ltration. Two manufacturers' cassettes were in use during the study, namely Agfa and Kodak with two di erent screen- lm combination speeds; 200 and 400. Since the study was aimed to provide patient dose estimates based on the patient's anatomical data and exposure parameters utilized for the speci c examination, the pe6(a)91pp6(a)91pp6(a)91pp6004802cn /TT16x71ics of tlm-Distances (FFDs)9(im)4(e)-5(d t)6(o pg5 Tw -p Tw T* [(s)5(

Hospitals	ESD for individual examinations in all rooms				vipuÃaQ õsMb ^4?Âr̨A M m		M õo	

is study also revealed that there were inconsistencies in the use of the focus lm distances as recommended in the EC quality criteria. e EC criteria recommend an average FFD of 115 cm and a range of 100–150 cm. Most diagnostic centers used FFD values below the average values (115 cm) but equal to the minimum recommended value (100 cm). Since ESD is inversely proportional to the square of the FFD, for the same kV and mAs the dose reaching the patient is expected to be high. Although the general trend across all centers is the use of lower FFDs and this, in part, might explain higher ESDs, it can be seen that the results do not show this as a universal trend (some centers with low FFDs present mean ESDs around 2 mGy, some much, much higher). It is worth noting that changing FFD could be a good change, but will still not solve all discrepancies found in the study. It is therefore essential that policies on quality control and assurance monitoring programs be enforced in the hospitals to protect the patient against unnecessary exposures through repeat examinations [16].

Generally, ESD values for the same type of examination in the same room will vary due to the di erences in patient size and in the radiographic technique used by di erent radiographers. Variations in the ESD values between di erent X-ray rooms will additionally be due to di erences in radiographic equipment, lm type, processing, chemistry, and processing conditions. e mean ESD values for the individual examinations varied considerably across all hospitals and within hospitals. A particular hospital, H-7, recorded consistently higher ESDs than the other departments [17]. On closer investigation, it was revealed that the Automatic Exposure Control (AEC) device was consistently being incorrectly used or was frequently overridden by the radiographer for no apparent reason. Automatic exposure devices are intended to take some of the human error out of exposure factor selection, but overriding them has a detrimental e ect on patient dose. is particular issue (of not using AEC where they were available)

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