Radiation Dose measurements Survey During Hystrosalpingography in Sudan

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Abstract

The aims of this study were to measure the patients' entrance surface doses (ESDs), effective doses and to compare practices between different hospitals. This study conducted in five radiological departments: *(A)* Omdurman Teaching Hospital (20 patients), *(B)* Alnilain Diagnostic Center, (20 patients) *(C)* Asia Specialized Hospital (10 patients), *(D)* Khartoum Teaching Hospital (12 patients) and (*E)* The National Ribat University Hospital (10 patients).
Patients' doses were calculated using DoseCal software. The X-ray tube outputs were measured using Unfors Xi dosimeter. Effective doses were estimated using National radiological Protection Board (NRPB) software. The mean ESD was 20.1 mGy, 28.9 mGy, 13.6 mGy, 58.65 mGy and 35.7 mGy for hospitals *A,B,C,D,* and *E* ,respectively. The study showed wide variations in the ESDs with three of the hospitals having values above the internationally reported values. Number of X ray images, operator skills X ray machine type were shown to be a major contributor to the variations reported. Results have demonstrated the need for standardization of technique throughout the hospital. The results also suggest that there is a need to optimize the procedures.

1.Introduction

Hysterosalpingography (HSG) or uterosalpingography is the most frequently used diagnostic tool to evaluate the endometrial cavity and fallopian tube by using conventional x-ray or fluoroscopy since it emergence in 1910 [1]. Despite of the development of the imaging tools such as computed tomography (CT), Magnetic resonance imaging (MRI), labroscopy, hysteroscopy and ultrasound (US), HSG plays an extremely crucial role in the diagnostic assessment and treatment of infertility in female patients [2,3]. During the procedure, patients are subjected to fluoroscopic and radiographic exposures in genitourinary area which is very sensitive to radiation since it include the ovaries and uterus which impose radiation risks to patients. The partial exposure of patient results in a heterogeneous dose distribution; therefore the organ dose and effective dose values are more appropriate descriptors of patient dose and related risks. In the literature, still few studies were published regarding the radiation doses received by the patients [4,5,6] . These studies show wide differences in terms of dose, fluoroscopic time, number of radiographic images, equipment and inter-examiners variability. In addition, there is a need for continuous evaluation of patient dose because some data were outdated due to advancement in X ray generators and image receptor. In Sudan, Still few data are available in the field of patient doses and its related risks. Therefore, quantification of radiation dose, organ dose and effective dose is important. The aims of this study were to measure the patients' entrance surface doses (ESDs), estimate the effective doses and to compare practices between different hospitals.

2. Materials and Methods

2.1 Patient dose measurement

A total of 72 patients were examined (aged 23–44 y) for a period of 4 months in five radiological departments: *(A)* Omdurman Teaching Hospital (20 patients), *(B)* Alnilain Diagnostic Center, (20 patients) *(C)* Asia Specialized Hospital (10 patients), *(D)* Khartoum Teaching Hospital (12 patients) and (*E)* The National Ribat University Hospital (10 patients).

ESDs in this study were calculated using Dose Cal software developed by the radiological protection centre of Saint George' Hospital, London. The ESD was measured using the exposure factors (tube current time product (mAs) tube voltage (kVp) and focus to skin distance (FSD) and tube output. The X-ray tube output were measured in (mGy/mAs) using Unfors Xi Dosimeter (Unfors Inc., Billdal, Sweden) with accuracy better than 5%. ESD was calculated according to the following formula:

$$ESD = OPx\left(\frac{kV}{80}\right)^2 xmAsx\left(\frac{100}{FSD}\right)^2 xBSF$$

where(OP) is the output in mGy/ (mA s) of the X-ray tube at 80 kV at a focus distance of 1 m normalized to 10 mA s, (kV) the tube potential,(mA s) the product of the tube current (in mA) and the exposure time(in s), (FSD) the focus-to-skin distance (in cm) and (BSF) the backscatter factor. BSF was calculated automatically by the Dose Cal software after all input data were entered manually in the software. The tube output, the patient anthropometrical data and the radiographic parameters (kVp, mA s, FSD and filtration) were initially inserted in the software. The kinds of examination and projection were selected afterwards. ESD was used to estimate the organ equivalent dose (*H*) using software provided by the National Radiological Protection Board (NRPB-SR262) [7].

2.2 HSG technique

At the beginning of the procedure patient lie supine on the table in lithotomic position bends her knees and place her feet at the end of the table .A vaginal speculum inserted into the vagina ,the vaginal walls and cervix are cleaned with antiseptic solution. A canula inserted into cervical canal ,which attached with syringe fill with contrast medium (CM). after the injection of the CM, a minimum four films were obtained during conventional radiography by using 10x12 inch films with vertical center rays 5cm superior to symphysis pubis which include the flowing : AP plain radiograph, 2. AP film with CM to show the uterus, AP film with CM to show the uterine tubes, AP film with CM to show spill of CM in the peritoneal cavity. The technologist were performing the investigations as their daily practice. Demographic data: (age, height and weight and body mass index (BMI (kg/m^2)) and exposure factors: (kVp and tube current-time product (mAs)) were obtained for all patients.

Radiographic equipment

Five X ray machines were used in this study from different manufacturers and tube characteristics as illustrated in Table 1. All department used X ray film/screen with speed 400.

Table 1: X ray machine technical data

Hospitals	Type	Filtration mm Al	Maximum tube voltage(kVp)	Date of installation
A	Shimadzu1/2P13DK -85	1.5	150	2007
B	ShimadzuR-20J	1.5	150	2004
C	Toshiba,LTN-25m	1.5	125	2003
D	Toshiba	3.5	150	2005
E	Siemens	3.5	150	2004

3. Results

Patients body characteristics are presented in Table 2. Minor variations were observed among patient populations in terms of weight and BMI . The mean exposure factors used during image acquisition for all groups are shown in Table 3. The patient characteristics and exposure factors are comparable for both groups. The ESD, effective dose values and number of films for all patients groups are presented in the same table. The results show asymmetry in the dose distribution. This can be attributed to different factors: patient pathology, X ray machine characteristics, inter-operator differences.

Table 2 Patient characteristic, mean and Sd, Range in the parenthesis

Hospital	No.	Patient age (year)	Weight (Kg)	BMI (Kg/m2)
A	20	32.75±6.21 (24-43)	72.9±13.0 (50-95)	27.6±5.2 (18.65-35.08)
B	20	32.56±5.1 (25-40)	73.3±13.0 (60-105)	26.21±6.61 (14.46-41.01)
C	10	34.4±5.25 (27-43)	74.3±13.9 (52-97)	28±4.4 (20.31-34.03)
D	12	31.3±7.1 (22-40)	75.5±12.8 (54-91)	25.6±2.5 (20.7-29)
E	10	31.1±5.5 (24-39)	74±7.27 (62-85)	25.61±3 (20-29.6)

Table 3: Patient ESD (mGy), exposure factors and number of films per procedure

Hospital	Tube voltage (kVp)	Current time product (mAs)	No. of films	ESD (mGy)	Effective dose (mSv)
A	71.9±3.22 (66-77)	18.93±3.08 (12.6-24)	4 (1-4)	20.1±4.6 (11.8-27.4)	2.4 (1.4-3.3
B	77.9±4.72 (70-88)	24.05±2.54 (20-28)	4 (4-6)	28.9±6.3 (10.8-30.2)	3.5 (1.3-3.6)
C	75.6±4.50 (69-81)	23.4±4.62 (20-30)	4 (4-6)	13.6±4.1 (9.3-19.7)	1.6 (1.1-2.3)
D	68.8±6.05 (62-78)	158.4±53 (64-250)	2.8±0.8 (2-4)	17.5±4.6 (9.5-23.6)	2.1 (1.1-2.8)
E	68.7±3.4 (63-76)	490.9±210.6 (319-959)	5.3±2.7 (2-12)	35.7±7.8 (12.3-48.4)	4.2 (1.5-5.8)

4. Discussion

This study investigated the patient doses during HSG in three hospitals in Khartoum state. The main factors affecting patient's dose in HSG are: exposure factors, filtration, and source to surface distance (SSD), collimation, pathology and patient size. There were no significant differences between the two patients groups in terms of height, weight, BMI (Table 2). The tube voltage were comparable while tube current time product showed wide variations due to use of different exposure time. The quality of the radiation depends on the tube voltage and the total filtration of x ray beam. X ray beam filtration in Hospital D and hospital E high compared with the other three machines (Table 1).This result indicates that the patient dose and effective doses are higher compared to previous studies as illustrated in Figure 2. In comparison between ESD doses from previous studies, this value is higher more than previous studies, except the study of Clicchia et al [11]. A survey of radiation dose was made in this study for the different imaging techniques and radiological examinations performed in patients in child bearing age. The study revealed the urgent need for dose reduction techniques. Regular quality control may help to limit variations which are due to equipment related factors.

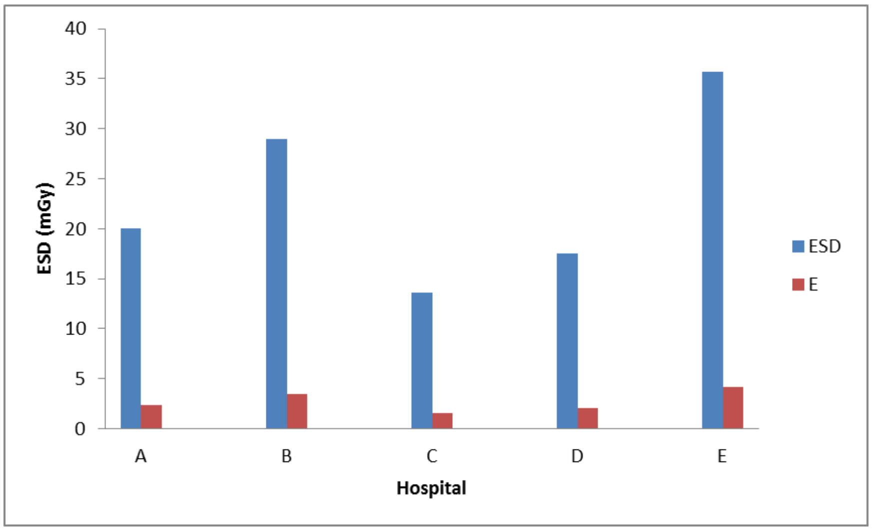

Figure 1: The mean ESD during HSG procedures in various hospitals

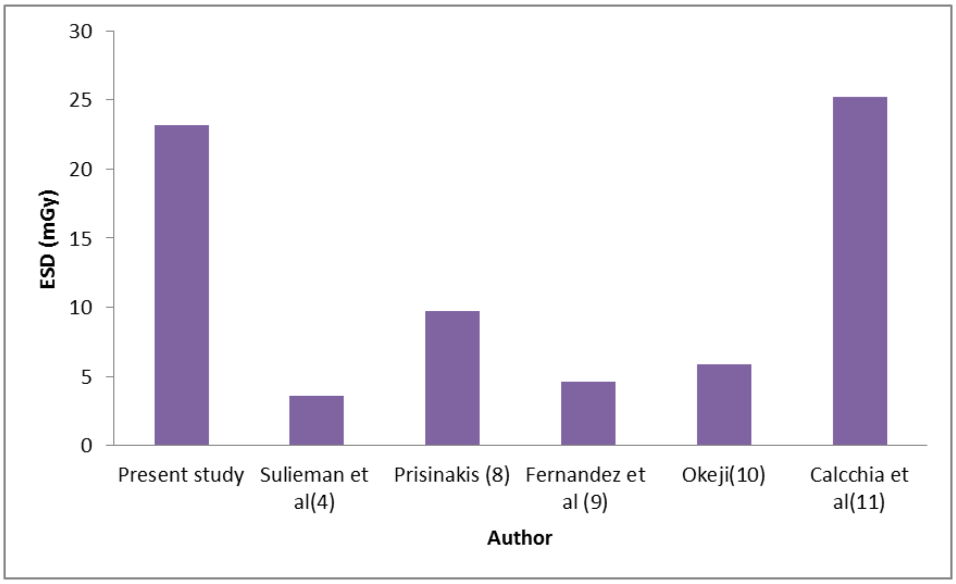

Figure 2: The mean ESD during HSG procedures in various studies

5.Conclusion:

This study investigated the patient doses during HSG in five hospitals in Khartoum state. The mean ESD result for all patients higher than previous studies. The dose values showed wide variations attributed to the machine characteristics, technique and operator experiences. In addition, Vital organs, i.e ovaries and uterus exposed to high dose which increase the probability of cancer and heritable effects which suggest the need for dose optimisation.

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