

ESTIMATION OF EFFECTIVE DOSE DURING HYSTROSALPINGOGRAPHY PROCEDURES

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Abstract

Hysterosalpingography (HSG) is the most frequently used diagnostic tool to evaluate the endometrial cavity and fallopian tube by using conventional x-ray or fluoroscopy. Determination of the patient radiation doses values from x-ray examinations provides useful guidance on where best to concentrate efforts on patient dose reduction in order to optimize the protection of the patients. The aims of this study were to measure the patients' entrance surface air kerma doses (ESAK), effective doses and to compare practices between different hospitals in Sudan. ESAK were measured for patient using calibrated thermo luminance dosimeters (TLDs, GR200A). Effective doses were estimated using National radiological Protection Board (NRPB) software. This study was conducted in five radiological departments: Two Teaching Hospitals (A& D), two private hospitals (B and C) and one University Hospital (E). The mean ESD was 20.1 mGy, 28.9 mGy, 13.6 mGy, 58.65 mGy, 35.7, 22.4 and 19.6 mGy for hospitals A, B, C, D, and E, respectively. The mean effective dose was 2.4 mSv, 3.5 mSv, 1.6 mSv, 7.1 mSv and 4.3 mSv in the same order. 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, fluoroscopy time, operator skills x-ray machine type and clinical complexity of the procedures were shown to be major contributors to the variations reported. Results demonstrated the need for standardization of technique throughout the hospital. The results also suggest that there is a need to optimize the procedures. Local DRLs were proposed for the entire procedures.

Key words: Patient dosimetry; Radiation risks, Effective dose; TLD, HSG

1. INTRODUCTION

Since its emergence in 1910, Hysterosalpingography (HSG) or uterosalpingography became the most frequently used diagnostic tool to evaluate the endometrial cavity and fallopian tube by using conventional x-ray or fluoroscopy [Chalazonitis et al., 2009]. Despite the development of the imaging tools such as computed tomography (CT), Magnetic resonance imaging (MRI), laparoscopy, hysteroscopy and ultrasound (US), HSG plays an extremely crucial role in the diagnostic assessment and treatment of infertility in female patients [Úbeda et al., 2001, Krysiewicz 2001]. During the procedure, patients are subjected to fluoroscopic and radiographic exposures in genitourinary area; which is very sensitive to radiation, since it includes the ovaries and uterus. The partial exposure of patients result 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 few studies were published regarding the radiation doses received by the patients [Sulieman et al., 2008, Phillips et al., 2010, Plečaš et al., 2010] . 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 the patient's 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 (aged 23–44 y) were examined 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).

2.2 Radiation dose measurement

Radiation dose measurements were made for patients during HSG procedure using TL dosimeters GR-200A TLDs (LiF: Mg, Cu, P (FIMEL, France)). All TLD dosimeters shared the same thermal history. TLD calibration was according to international protocols for the range of energies used in the study in order to determine their response and their individual calibration factor (Martin et al., 1998, Sulieman et al., 2007). The TLD signal was read using PCL3 TLD automatic reader (FIMEL, France) which allows fast readings of a large number of TLD samples with a reproducibility of $0.3\pm 0.5\%$. The irradiated chips were read out at a 55 0C preheat temperature and the signal was acquired from 55 0C to 260 0C with heating rate of 110C/s. All TLDs were annealed in annealing oven (TLDO, PTW: Freiburg, Germany) at 240°C for 10 minutes. ESAK was used to estimate the organ equivalent dose (H) using software provided by the National Radiological Protection Board (NRPB-SR262,1996).

2.3 HSG technique

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

2.4 Radiographic equipment

Five x-ray machines used in this study are from different manufacturers and have different tube characteristics as illustrated in Table 1. All departments used x-ray film/screen with speed of 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	Shimadzu R-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 and inter-operator differences.

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

Hospital	No.	Patiente age (years)	Weight [kg]	BMI [kg/m ²]
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)	26.5±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)
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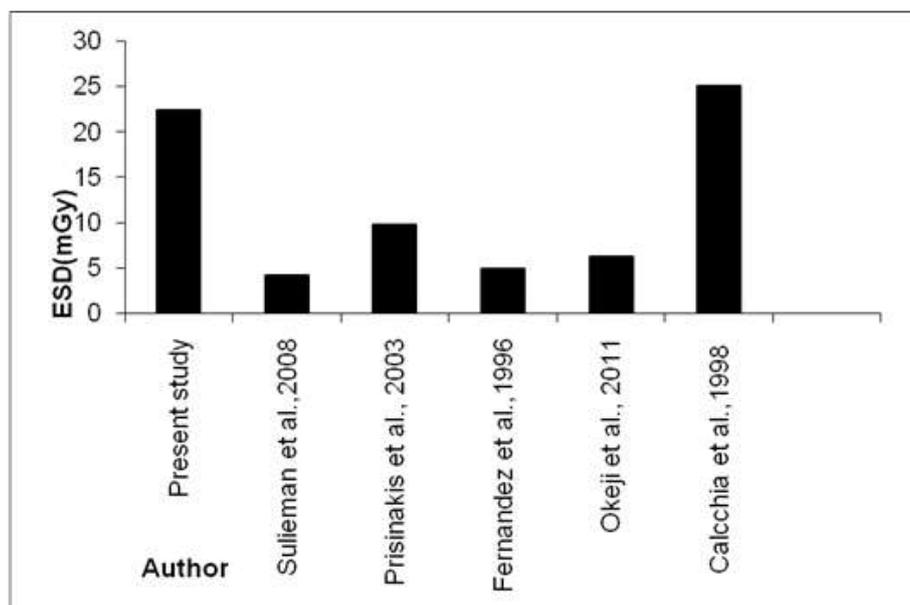
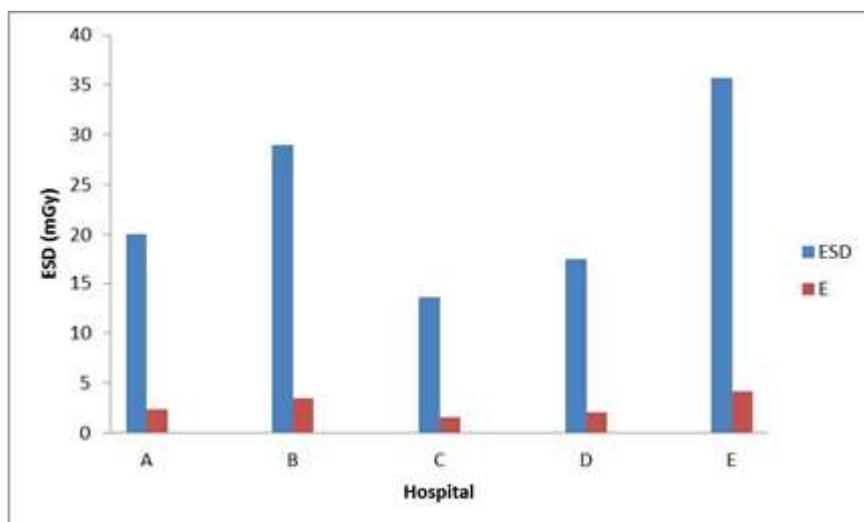
A	71.9±3.22 (66-77)	18.93±3.08 (12.6-24)	4 (1-4)	20.1±4.6 (11.8-27.4)	2.4 (1.4-3.3)
B	77.9±4.72 (70-88)	24.05±2.54 (20-28)	4 (4-6)	28.9±6.3 (10.8-30.2)	3.5 (1.3-3.6)
C	75.6±4.50 (69-81)	23.4±4.62 (20-30)	4 (4-6)	13.6±4.1 (9.3-19.7)	1.6 (1.1-2.3)
D	68.8±6.05 (62-78)	158.4±53 (64-250)	2.8 (2-4)	17.5±4.6 (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 (2-12)	35.7±7.8 (12.3-48.4)	4.2 (1.5-5.8)

Discussion

This study investigated the patient doses during HSG in five hospitals in Khartoum state. The main factors affecting patient's dose in HSG are: exposure factors, filtration, 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 was 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 were high compared to the other three machines (Table 1).

The results indicate 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, our value is higher than the previous studies, except the study of Clicchia et al [Calicchia et al., 1998]. 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.



5. Conclusion

This study investigated the patient doses during HSG in five hospitals in Khartoum state. The mean ESD results for all patients were higher than the 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 were exposed

to high doses which may increase the probability of cancer and heritable effects; this suggests the need for dose optimization.

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