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COMPARISON OF RADIATION DOSE IN HSG WITH MAGNIFICATION FACTOR IN FLUOROSCOPY

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ABSTRACT

Our main aim of this study was a comparison of radiation dose in HSG with magnification factor. The study was carried on total 38 female patients fulfilling the inclusion criteria who had been suggested for HSG procedure. Among this total population they were divided in four groups according to their BMI. Patient with normal BMI was in group 1, underweight in group2, overweight in group3 and obese in group 4. 24 patients were in group one and were divided 12 each for MF 1 and 2. 5 patients was in group2 and group 3 and were divided into 3 and 2 for MF 1and 2 respectively. Similarly 4 patients were in group4 and were divided into 2 in each MF. Pelvic measurement was taken for each patient prior to the procedure. By using lottery method we selected the magnification factor for each patient and proceeded with the procedure. Exposure was done with intermittent fluoroscopy Data was collected from the dose information stored in the Iconos system. Data was collected only from two exposures and fluoro information was ignored. Performing statistical analysis on group one i.e. with 24 patients, 12 patients with each MF 1 and 2. We carried an independent test on group 1 patients and keeping P value 0.05, we found that the p value was to be 0.004, so this study shows that there is a significance difference in the average radiation dose between magnification factor 1 and 2.

KEYWORDS: Radiation Dose, HSG, Radiology examination

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INTRODUCTION

Hysterosalpingography (HSG) is a radiological procedure in which the contrast is injected into the uterus to study the uterine cavity and fallopian tubes.Sir R. Kramer et al., in the study of Equivalent Dose to the Organ and Tissue in HSG was calculated with the FAX (Female Adult Voxel) phantom. They found that the conversion coefficient increases with increasing in voltage and filtration so equivalent dose to the organ decreases because of increasing the tube voltage or the filtration reduces the mAs for constant exposure to detector systemFor the whole range of tube voltage the FAX ovarian dose was found to be 25% which is greater than EVA ovarian dose for the smaller field size, while for large field size it was found to be 18%. The average conversion coefficient between ovarian equivalent dose and ESAK was found to be 0.22. These were compared with the conversion coefficient for EVA phantom of 24 cm × 30 cm field at 80 kVp and 70 kVp, respectively. For 80 kVp, the CCs was 0.24 and 0.20 for 70 kVp. They have also found that increasing the tube voltage from 70 kVp to 120 kVp the CCs increases by 65%. The uterus equivalent dose of EVA phantom was found out to be 36 % greater than the equivalent dose of the uterus in the FAX phantom over the whole range of phantom energies. It was found out that the orientation of the field with regard to the width and height can cause a difference between 2% and 15% for the organ equivalent dose. The CCs presented can be served as the tool for the patient dosimetry[1.]In the study "patient dosimetry in hysterosalpingography: a comparative study," sir ACM Gregan et al., at the department of radiology, Birmingham Women's hospital NHS trust, ovarian dose for 45 women undergoing HSG were calculated by using lithium borate TLD by measuring entrance surface dose in standard positions with analogue and digital system. The digital system used was the Philips optimus BV29 fluoroscopic unit with a c-arm which was fitted with a calibrated dose area product meter. The radiographic parameter was automatically controlled. 21 patients were investigated using analogue radiography and 24 patients were investigated by using digital radiography system. HSG was performed by four experienced operator, two radiologist and two gynecologists on both the analogue and digital system. In analogue system, the TLD were placed posteriorly and in digital system, it was placed anteriorly to measure entrance surface dose. The TLDs were placed on the different landmarks: 1) anteriorly on the left and right ASIS, 2) midway between the left and right ASIS, 3) on the pubic symphysis pubis, and 4) posteriorly in corresponding places. The input dose rate to the image intensifier on the analogue system was 32 μ Gy $min^{-1}$and for digital system was 14 μGy min^{-1}. Since the TLD on pubis symphysis was in the primary beam, so by using montecarlo method, the ovarian dose was calculated by this ESD. Controlled radiograph was taken and the radiographic information was documented following the examination. There results show no significant difference in screening time and fluoroscopy kV employed between the two groups. The limitation for this method used was the minimum dose detectable for the TLD is in order of 100 μGy, the range of entrance dose measured was to be 0.2–45.7 mGy. The range of DAP readings was 10–46 $cGycm^2$. There results were demonstrate the six fold ovarian dose reduction with digital system with compare to the analogue system. They concluded that the use of digital radiographic system with image capture facilities can lead to a significant dose reduction when compared with analogue systems. With the use of digital fluoroscopy system, the potential dose reduction should be taken into consideration when investigation involving exposures to the gonadal region such as HSG are to be performed.[2]

In our presence study the aim is to Comparison of radiation dose in HSG with magnification factor in fluoroscopy.

METHODOLOGY

STUDY SITE: KMC Hospital, Manipal, Udupi, South Karnataka, India
STUDY DESIGN: Cross sectional study
SAMPLING TECHNIQUE: Lottery method
STUDY DURATION: 1 Year (2014 – 2015)

Study Criteria
Inclusion criteria
All the married female patients of child-bearing age with indication of infertility that was being suggested for HSG.

Exclusion criteria
Where 28-day rule was not applicable

Sample Size: 38
Formula used:

$$n = (z_{1}- \alpha/2)^2 \ (\sigma)^2 / (d)^2$$

Where

$Z_{1} - \alpha/2$ - 1.96
σ - Standard deviation
d –10% of mean

Source of data

1. Fluoroscopic Axiom Iconos unit console.

MATERIALS

1. Fluoroscopic X – Ray machine with 800 mA station (Semiens Axiom Iconos R 200)[4]
2. Automatic Exposure Controls
3. Contrast media - water soluble e.g., Angiograffin
4. Foley's catheter

Study Procedure

- The study was approved by institutional research committee, SOAHS and ethical clearance was obtained from KH ethical committee.
- The patients coming for HSG procedure to the department of radiology at Kasturba Hospital were included in the study.
- The patient fulfilling the inclusion criteria was taken for the study and pelvis circumference was measured (inch).
- Total number of patients undergoing the procedure was 38 married females.
- Patient BMI was checked and according to the BMI they were divided into four groups: Group 1 (normal BMI), Group 2 (underweight), Group 3 (overweight), Group 4 (obese).
- By using lottery method, different magnification was selected for each patient in each group and proceeded with the procedure.
- The table 1 shows the total number of patients and distribution of patients in different group and different MF (1 and 2).

Table 1
The number of patients in different groups and MF

Groups	No. of patients	MF 1	MF 2
1	24	12	12
2	5	3	2
3	5	3	2
4	4	2	2
TOTAL	38	20	18

- The study was carried out with over couch x-ray tube, fluoroscopic x-ray machine with 800 mA station (Semiens Axiom Iconos R 200) with AEC (automatic exposure control) facility.
- Being a contrast study, written consent was taken from the patients prior to the procedure and procedure was explained in understandable language. Patients were positioned supine in lithotomy position on the fluoroscopy table and the central line of collimator light was aligned to the midsaggital plane of the body.
- Central ray was centered at the symphysis pubis.
- In control console, the routine protocol was selected, which has automatic exposure control (AEC) and operates at particular kVp according to the body weight of the patient.
- The magnification factor was selected manually, which has been taken out from the box (using lottery method).
- Half of the patients were imaged with magnification factor 1 and other half was imaged by magnification factor 2.
- The procedure was started by placing the foley's catheter into the uterus, the foley's bulb were inflated with saline at the internal ostium of the cervics mainly for the immobilization of the catheter during the procedure.
- Position of the patient was checked using fluoroscopy and further procedure was carried by injecting the contrast media into the uterus through the catheter.
- The contrast flow during injection was visualized under intermittent fluoroscopy and different exposure was made whenever it is required. The filming was done as follows:

1) **Scanogram**- **fluoro image**
2) **During filling of tube - spot film**
3) **At the time of peritoneal spillage** –**spot film.**

- All the filming weredone without altering the collimation size as per the collimation of magnification.
- Dose Area Product was noted after the completion of procedure from the control console.
- Fluoroscopy reading was ignored, DAP reading was taken only from two exposures from each procedure.

Statistical Analysis

1. Independent t-test
2. The data obtained will be statistically analyzed by using SPSS version 16 software.

RESULTS

In total, 38 patients were examined for this study and according to their BMI, 38 patients were divided into 4 groups (Table 1).

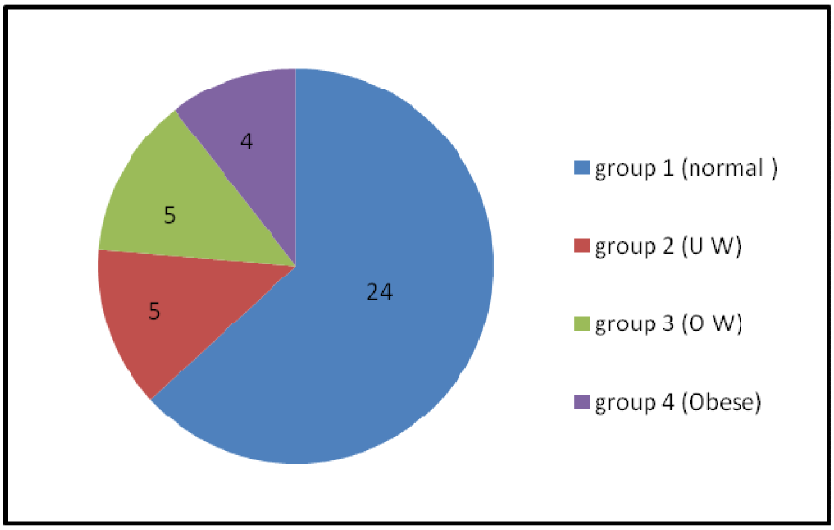

Figure 1
Total number of patients in each group

We performed statistical analysis only on group 1. Group 1 had 12 patients each in MF1 and MF 2. Finding group statistics on group 1, the mean value for MF 1 was found to be 27.733, and mean value for MF 2 was found to be 35.65 and standard deviation was found to be 3.29 and 2.28, respectively.

Table 2
Mean and standard deviation in group 1 patients

Group Statistics					
	Magnification factor	N	Mean	Std. Deviation	Std. Error Mean
Radiation	factor1	12	27.7333	3.29637	.95158
	factor2	12	35.6500	7.93112	2.28952

Performing independent test on group 1 patients and keeping P-value of 0.05, we found that the P-value to be 0.004. Since the calculated P-value is less than 0.05, this study shows that there is a significance difference in the average radiation dose of 7µ Gy*m² between magnification factors 1 and 2.

Table 3
Significance difference in radiation dose with MF1 and 2 in group 1 patients

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Radiation	Equal variances assumed	3.052	.095	-3.193	22	.004	-7.91667	2.47939	-13.05862	-2.77472
	Equal variances not assumed			-3.193	14.690	.006	-7.91667	2.47939	-13.21109	-2.62224

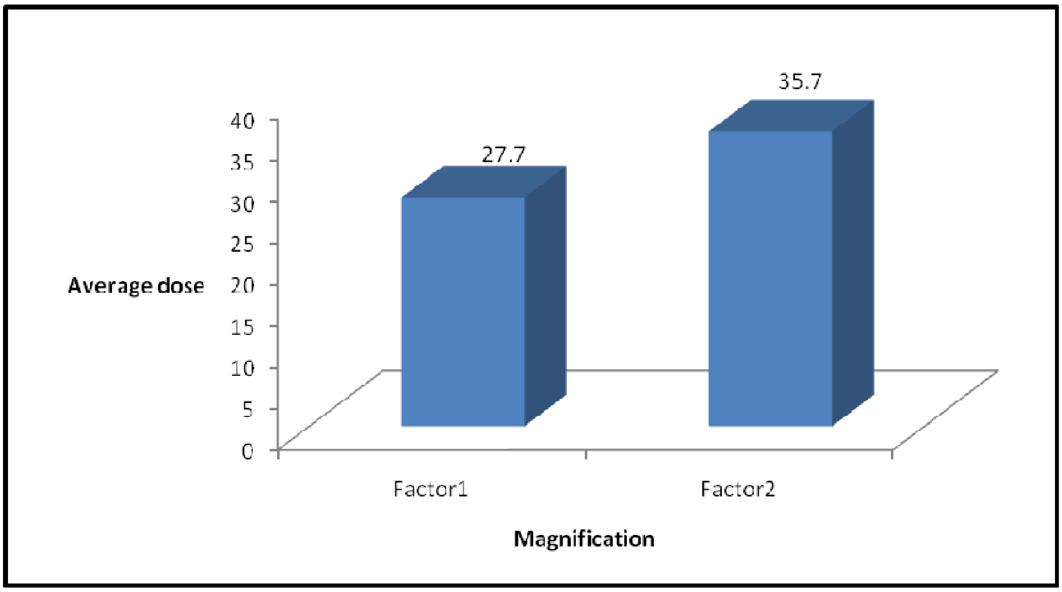

Figure 2
Histogram showing average dose against magnification factors 1 and 2

The total number of patients in groups2, 3, and, 4 was very less of 5, 5, and 4, respectively, so we could not perform statistical analysis with these less samples. The table 4 shows the mean difference and standard deviation (SD) for these three groups which also shows that the mean dose increases along with the increasing MF. It shows that there is clinically increasing in average dose with increasing the MF.

Table 4
Mean and SD of group 2, 3 and 4 patients

GROUPS	MF	B M I	P C (inch)	kVp	mAs	DOSE (μ Gy*m²) (DAP)		Total	Mean	S D
						A	B			
2 (U W)	I									
	1	16.2	32	85	3.6	8.5	8.8	17.3		
	2	16.7	30	85	3.3	8.5	8.8	17.3		
	3	18	33	87.5	4	9.3	9.9	19.2		
									17.93	1.096
	II									
	1	17.5	33	85	7.8	12.3	12.4	24.7		
	2	16.8	34	85	6.8	11.2	11.8	23		
									23.85	1.202
3 (O W)										
	I									
	1	26.5	42	90	5.4	16.5	18.2	34.7		
	2	26	22	81	5.9	20.3	21.4	41.7		
	3	28.6	41	93	6.9	20	24.5	44.5		
									40.3	5.04
	II									
	1	28.9	43	96	14.7	29.2	29.4	58.6		
	2	27.8	40	93	14.8	26.9	27.8	54.7		
									56.65	2.75
4 (obese)	I									
	1	31.6	44	96	6.4	24.3	24.5	48.8		
	2	39	41	93	7.2	24.1	25.6	49.7		
									49.25	0.63
	II									
	1	30.7	40	93	12.5	24.6	25.2	49.8		
	2	31	42	95	14	26.9	27.5	54.4		
									52.1	3.25S

In group2, mean for MF 1 and 2 was found to be 17.93 and 23.85, respectively, and SD to be 1.09 and 1.2, respectively.
In group3, mean for MF 1and 2 was found to be 40.3 and 56.65, respectively, and SD to be 5.0 and 2.75, respectively.
In group 4, mean for MF 1 and 2 was found to be 49.25 and 52.1, respectively, and SD to be 0.63 and 3.25, respectively.
Our study results that increasing the magnification leads to increase in dose to the patients with the mean difference in the average radiation dose of 7μ Gy*m².

DISCUSSION

In a study conducted by sir A. C. M.Gregan et al. on Patient dosimetry in hysterosalpingography which is a comparative study, they concluded that the use of digital imaging system with image capture facilities gives considerably less ovarian dose as compared with analogue radiographic system. They found that median dose achieved by digital system was to be sixfold lesser than that with analogue system. Sir R. Karmer et al., in the study of Equivalent dose to organs and tissues in hysterosalpingography calculated with the FAX phantom, reported dose variation with exposure parameters[3]. There calculation showed an increase of ovarian conversion coefficient by 65% and uterus by 55% when the tube voltage increased from 70 kVcp to 120 kVcp. They also demonstrated that increasing the tube voltage decreases the equivalent dose to the uterus and ovaries by up to 50 % so they concluded that one step to reduce the exposure to the patients is to increase the tube voltage and other parameter can also be the increase of filtration. Finally, in their study, they pointed out that orientation of the field with regard to width and height can cause a difference between 2% and 15% for the organ equivalent doses. Increasing the magnification decreases the field of view this leads to more use of input phosphor and simultaneously tube current will increase automatically. Increasing the tube current is proportional to the patient receive dose.The result obtained in this study was determined by using over couch x-ray tube; digital imaging system with fluoroscopy and image capture facilities and demonstrate variation of average patient's dose with the use of MF. Increasing the magnification increases the Dose Area Product (DAP) from 27.73 µGy*m² with MF 1 to 35.65 µGy*m² with MF2 in group 1 (normal BMI) patients. The mean difference was found to be 7 µGy*m². Previous study showed that radiation dose is reduced by the use of digital imaging system; furthermore, we can optimize and lower the dose received to gonadal region by avoiding the MF particularly in this study. Our study demonstrates the increase of dose by the mean difference of 7 µ Gy*m², increasing the dose along with the increase in magnification can have radiation induced impact on the patients and also to the professional.

CONCLUSION

According to this study, there is a statistical significance difference in the average dose between magnification factor 1 and 2. Our study presents the results of increasing of radiation dose along with the increasing of magnification factor. The study results shows the mean difference in average radiation dose between MF 1 and 2 to be 7.9 µ Gy*m². According to this particularly study, reducing the magnification can also be the one dose reduction technique, mainly when we are dealing with gonadal region and exposure to this region is unavoidable during the procedure. Keeping infertility as the common indication in mind and usually the patients undergoing for this procedure are typically very young and of child bearing age. Moreover concerning over the radiation dose to ovaries and uterus and not to worsen the condition of patients with diagnostic radiation and by using ALARA concept one must optimize the radiation exposure to an individual, and this can be done by using magnification only in its necessities for the study along with the other technical factor like fixed SID, high kVp and filtration.

Limitation

- Our study has not discussed about the variation in image quality when switching the MF from 1 to 2. This study on image quality with magnification can be taken further in future studies.
- The sample size for our study was small as this was a time limited study, so statistical analysis was done only for group 1 (normal BMI) with 24 patients (12 in each MF 1 and 2). We were unable to collect the samples for underweight, overweight and obese patients.
- Also there were no similar studies found to support our finding till the date.

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