

Less is More: Reducing Radiation in Hysterosalpingography Through Targeted Interventions

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ABSTRACT

Background: Hysterosalpingography (HSG) is used for evaluating female infertility, particularly for fallopian tube patency and uterine cavity abnormalities. It involves radiation exposure, which may pose potential risks to women of reproductive age. Therefore, optimizing radiation dose according to the ALARA principle is essential.

Objective: To investigate the radiation exposure time of patients undergoing fluoroscopic hysterosalpingography (HSG) before and after implementation of interventions aimed at reducing the radiation exposure.

Methods: After approval from Institutional Review Board, the study was conducted in radiology department of Shifa International hospital, Islamabad. The prospective study includes 120 female patients. The study was performed in two phases: February–May 2022 (Phase 1) and September–December 2022 (Phase 2), separated by period of interventions to achieve the fluoroscopy screening time according to National Diagnostic Reference Level (NDRL) back in 2016. Interventions include training the radiology residents, equipment optimization, patient counselling and improved coordination between fluoroscopic operator and assisting staff. Paired-T test was employed to compare the mean radiation exposure time in normal studies in Phase 1 with that of normal studies in Phase 2, and to also compare the mean radiation exposure time in abnormal studies in Phase 1 with that of abnormal studies in Phase 2.

Results: Patients' ages ranged between 25-35 years with an average of 30 years. The mean radiation exposure time in Phase 1 was 94.9 seconds for normal studies and 181.5 seconds for abnormal studies. In Phase 2, the mean exposure time was reduced to 45 seconds for normal studies and 46.5 seconds for

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abnormal studies. Paired t-tests showed significant reductions in exposure times in both groups, with p-values < 0.005.

Conclusion: Significant reductions in radiation exposure time were noted, highlighting the effectiveness of the interventions.

Keywords: hysterosalpingography, radiation exposure, fluoroscopy, radiation dose

INTRODUCTION

Infertility is commonly described as the inability to produce spontaneous pregnancy with one year of regular unprotected sexual intercourse [1-3]. World Health Organization states that 50 to 80 million people suffer from infertility around the globe. Female factors contribute 50% of infertility while male factors attribute to 20 to 30% of all infertility cases [4-6]. Causes for female infertility can be ovulatory in origin (25%), endometrial abnormalities (15%), tubal pathologies (12%), while other uterine abnormalities contribute towards 11% [7,8]. HSG is a useful diagnostic tool for radiologists to rule out any uterine anomalies or fallopian tube blockage that can cause infertility or subfertility in young females. In HSG, a radiopaque contrast is introduced into the female reproductive tract under fluoroscopic guidance performed during the early proliferative phase of the menstrual cycle (days 7-10) commonly known as “the rule of 10 of HSG” to optimize the visualization [9]. Patients undergoing HSG desire pregnancy while they are ignorant of the risk factors

imposed by medical radiation exams like infertility, birth defects and cancer to women in childbearing age, that have been reported in the recent literature [2]. Despite the potential complications that may accompany this procedure, HSG still remains one of the most commonly used imaging modality for evaluating infertility in the female partners of most couples in various health settings [10]. However, optimization is required in order to reduce the probability of the associated risks. However, this study evaluates the necessity to resort to "As Low As Reasonably Achievable (ALARA)" principle [11,12] and perpetration of corrective measures i.e. shielding techniques to ensure patient safety.

There is need to implement and evaluate interventions aiming at reducing the patient exposure, given the widespread use of HSG and its associated radiation risk. The study was conducted to assess the effectiveness of targeted measures in reducing fluoroscopy time during HSG procedures.

METHODS: This study was carried out at the Radiology Department of Shifa International



Hospital, Islamabad, to assess and reduce radiation exposure time during fluoroscopic hysterosalpingography (HSG) procedures. The study followed a two-phase approach, with data collected before and after implementing procedural and training-based interventions. The study was approved by the Institutional Review Board (IRB) to ensure compliance with ethical and safety standards. The study was carried out in two distinct phases with Phase 1 (pre-intervention) extending from February to May 2022 and Phase 2 (post-intervention) extending from September to December 2022. A total of 120 candidates were a part of this study with 60 being included in each phase. Amongst the 60 candidates in each phase, half of them had normal findings whereas the other half had abnormal HSG results. Radiation exposure times were recorded by two experienced radiologists using fluoroscopy time measurements during the procedure. HSG was either labelled normal or abnormal; normal if the fallopian tubes were patent with free contrast spillage and abnormal if there was any blockage or abnormality in one or both tubes. Between Phase I and Phase II, several steps were implemented to reduce radiation exposure times which included training of radiology residents (to optimize fluoroscopic techniques and reduce unnecessary exposure), technique improvement (adoption of ALARA principles and intermittent fluoroscopy), equipment

optimization (adjustment of beam quality to balance image quality with dose reduction), patient counselling (briefing patients before procedures to minimize movement and ensure cooperation), effective communication (improved coordination between the doctors and the assisting technicians and staff), monitoring and feedback (continuous tracking of fluoroscopy time and review sessions with radiologists). Paired T test was employed to compare the mean radiation exposure time in normal studies in Phase 1 with that of normal studies in Phase 2, and to also compare the mean radiation exposure time in abnormal studies in Phase 1 with that of abnormal studies in Phase 2.

The study was approved by institutional review board (IRB) of Shifa International Hospital, Islamabad (Reference No.932-207-201). All procedures informed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the principles of declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

RESULTS

The age of patients that were included in the study ranged between 25 to 35 years with the mean $\pm$ SD for phase 1 (normal study) being 30.0 ± 3.6 , 30.0 ± 3.2 for phase 1 (abnormal



study), 30.0 ± 3.6 for phase 2 (normal study) and 30.0 ± 3.1 for phase 2 (abnormal study). In Phase 1, the mean radiation exposure time was 94.9 ± 27.0 seconds for normal studies and 181.5 ± 56.9 seconds for abnormal studies. After the intervention, in Phase 2, the mean exposure time was significantly reduced to 45.0 ± 12.7 seconds for normal studies and 46.5 ± 12.2 seconds for abnormal studies which was significant according to paired t-test ($p < 0.005$) indicating a considerable impact of the

intervention in reducing radiation exposure during HSG procedures. The radiation exposure time in phase 1 was compared to the recommended National Diagnostic Reference Level (NDRL) (which is 42 seconds) which it exceeded drastically, demanding a need for optimization of scanning protocol. In the second phase of the study, through modified interventions and improving quality techniques, exposure time was significantly reduced (Table 1).

Table 1. Comparison of patient age and radiation exposure time before and after targeted interventions during hysterosalpingography

Variable	Phase 1: Normal	Phase 1: Abnormal	Phase 2: Normal	Phase 2: Abnormal	Statistical significance
Age, years, mean $\pm$ SD	30.0 ± 3.6	30.0 ± 3.2	30.0 ± 3.6	30.0 ± 3.1	NS
Radiation exposure time, seconds, mean $\pm$ SD	94.9 ± 27.0	181.5 ± 56.9	45.0 ± 12.7	46.5 ± 12.2	$p < 0.005$
NDRL, seconds	42	42	42	42	—
Exposure time above NDRL	Yes	Yes	Slightly above NDRL	Slightly above NDRL	—

The changes observed in the radiation exposure time which are evident of the fact that the interventions produced significant results in figure 1. Radiation exposure time for both normal and abnormal studies reduced considerably in phase 2 as compared to phase 1.

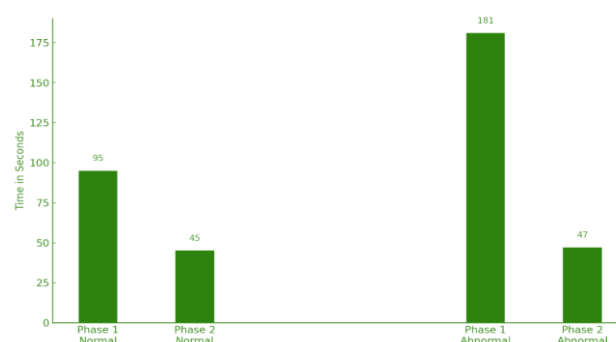


Figure 1: Effect of intervention on radiation exposure time

DISCUSSION

Infertility is a widespread issue in Pakistan, impacting an estimated 15% of couples, and this accounts for a large percentage of gynaecological conditions. Despite the issue being so common, it still has a certain stigma attached to it probably because fatherhood is loosely translated to manhood and motherhood to womanhood. While both male and female causes are equally important, it's the women that bear the brunt of this "curse" as it's called. They're subjected to not only emotional distress but even physical violence in some cases when they're not able to reproduce. Quite frequently, they also face social exclusion when they're not invited to weddings or birthday parties as they "might cast a bad shadow" on the bride or children in question, as observed in a study [13]. All this inevitably causes anxiety, depression and suicidal ideation amongst subfertile or infertile women of childbearing age. However, it is a multifaceted problem with a lot of contributing factors like socio-economic status, family structure and personal psychological struggles.

This establishes the need for having effective methods of evaluating infertility. One of them is HSG and while it is a useful tool, the radiation exposure might cause a potential long-term threat which is why it is immensely important to reduce the radiation exposure time

as much as possible while abiding by ALARA principles.

Training of Radiology Residents:

This study concluded that training of radiology residents helped reduce the radiation exposure time. The trainees were instructed to work in a systematic manner with designated roles for each member of the team. The residents were instructed to attend teaching sessions as well as simulations to make sure they knew the skill well. Making sure the residents knew the normal morphology as well as common abnormalities improved the expertise of the residents. These findings are in agreement with previous studies showing that fluoroscopy time varies significantly with operator experience [14]. Similarly, dose optimization studies have emphasized that operator-dependent factors, including familiarity with normal and abnormal findings, play a key role in reducing exposure [15].

Intermittent Fluoroscopy and Equipment Optimization:

The use of intermittent (pulsed) fluoroscopy was another important factor in reducing radiation exposure. Previous studies have shown that pulsed fluoroscopy can reduce radiation dose by up to 30–50% without affecting image quality [16]. In HSG specifically, optimization of fluoroscopic



techniques has been associated with significant reductions in patient dose [15].

More recent studies also support these findings. Chahine et al. reported substantial dose reduction with the use of optimized imaging techniques, including last-image hold, without compromising diagnostic accuracy [17]. Another recent European study also shows that fluoroscopy loop recording coupled with last-image significantly reduces radiation exposure without compromising on the image quality [18]. Equally important, if not more, is equipment optimization i.e. making sure the equipment is checked regularly and is functioning efficiently as part of routine maintenance.

Patient Counselling:

Patients were also counselled before the process and consent was taken before bringing the patient into the fluoroscopy room. All of their concerns and questions were addressed before starting the procedure. This pattern was also noticed during a study conducted in Turkey by Kinci MF et al., it was found that a lot of patients sought information regarding HSG from the internet which made them more apprehensive about the procedure whereas when they were interviewed after the procedure, they explained that the procedure was not painful and that it went smoother than they had anticipated [19].

Other more recent studies also back the role of counselling. Research has indicated that anxiety and perceived pain in patients undergoing HSG can be decreased by using structured educational interventions [20,21]. Enhanced patient cooperation due to anxiety reduction can in turn lead to shorter procedure time and a considerable reduction in radiation dose.

Improved Coordination Between Medical Staff:

Effective communication was ensured between the doctors performing the scan and the technicians and nurses assisting the scan. With specific roles assigned to every member of the team, the procedure was done without any confusion or hassle for each patient.

Continuous Monitoring and Feedback:

Continuous monitoring and feedback put added checks on the procedure and its effectiveness leading to a smoother process. This study also highlighted the fact that audits, reforms and interventions can yield better results and improve the course of any procedure. However, studies should be conducted at intervals to ensure patient safety where the patient can be exposed to ionizing radiation [22].



Comparison with Radiation Dose Literature:

Existing literature supports the idea that factors like operator experience and expertise, equipment used and techniques employed, all affect radiation exposure in HSG [23,24]. Moreover, certain studies also highlight the importance of establishing diagnostic reference levels (DRLs) to standardize radiation exposure in such procedures. One such example wherein the need for institutional DRLs in HSG has been emphasized to ensure safe practice and reduce variation in radiation exposure is emphasized in a study [25]. Our country Pakistan currently lacks sufficient data on the subject which highlights the need for more studies on the matter so that safer radiological practices can be followed.

LIMITATIONS

Like any study, this study also had a fair share of limitations. Exposure time was documented however it is not the most accurate method for quantifying exposure. Several other factors like presence or absence of shielding and type of shielding are important, among others, like distance from the source. These may significantly affect the radiation exposure. The sample size used was relatively small which may negatively impact the accuracy and validity of the results. A larger sample size

would produce more reliable results. There is not enough local data to which this study could have been compared. Moreover, the seniority of the residents performing HSG could have also impacted the results with a decreased exposure time for more senior residents. Senior residents are more likely to produce results similar to those of consultant radiologists as compared to junior residents [23]. This shows that results are affected by level of expertise of the team involved.

CONCLUSION

The objective of this study was to see if interventions like structured training, intermittent fluoroscopy, equipment optimization and patient counselling can affect radiation exposure time during HSG. The results showed significant reduction in radiation exposure time in both normal and abnormal studies; a correlation observed in existing literature as well. This also goes to show how relatively simple and practical measures can improve patient safety and experience during HSG. Consistent efforts to introduce all these interventions across the country and to establish local diagnostic reference levels, are needed so that ionizing radiation is used more responsibly. Moreover, owing to lack of adequate local data on the matter, such audits and studies should be routinely employed.



DECLARATIONS

Funding

The authors did not receive any financial assistance, grants, or external funding for the design, conduct, analysis, or publication of this study.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

ACKNOWLEDGEMENTS

None.

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All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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