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Enhanced Radiation Safety Protocol Adoption for Reducing Radiation Burden in Cath Lab During Angioplasty

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1. ABSTRACT

1.1. Introduction: Ionizing radiation remains an integral part of all Percutaneous Coronary Interventions (PCI). Prolonged exposure to low-dose radiation confers a small but definitive stochastic risk for developing malignant diseases, skin damage, or eye problems. Reducing dose exposure in cath. lab on day today practice is of utmost important. Our aim was to test reduction in the amount of radiation generation [Air Kerma (AK) and Dose Area Product (DAP)] while using the optimal shielding mechanism.

1.2. Materials and Methods: Five hundred and nineteen (519) randomly selected patients who underwent angioplasty procedures were enrolled. The study was conducted from 1st June 2019 to 31st May 2022. The PCI procedures were carried out at a single center.

1.3. Results: The mean AK from our cohort when compared to other published studies was significantly lesser than six studies and higher than one study. When compared with enhanced radiation safety protocol cohort, our mean AK was lesser than four centers and more than two centers. These dose reductions were achieved without increasing the volume of contrast media, fluoroscopy time or rates of procedural complications.

1.4. Conclusion: Optimizing the radiation safety protocol effectively reduces radiation exposure in patients and operators during cardiac catheterization procedures.

1.5. Keywords: Cardiac catheterization; Patient safety; Radiation exposure; Radiography; Interventional; Risk factors

2. INTRODUCTION

Radiation exposure of Interventional cardiologist in catheterization suite is a growing concern [1]. Ionizing radiation remains an integral part of all Percutaneous Coronary Interventions (PCI). For operators as well as technical staff members employed in a cardiac catheterization suite, prolonged exposure to low-dose radiation confers a small but definitive stochastic risk for developing malignant diseases, skin damage, or eye problems [2-4]. Reducing dose exposure in cath. lab on day today practice is of utmost important as it is causing moderate to severe harmful effects on all stakeholders of cath. Lab [5]. As per ALARA (As Low As Reasonably Achievable) principle there are three broad strategies i.e., reducing cath. lab time, distance from the primary beam and shielding. While first two strategies are difficult to adopt, however, the third strategy gets practised as per standard recommendations in any standard cath. lab. Our aim was to evaluate reduction in the amount of radiation generation [Air Kerma (AK) and Dose Area Product (DAP)] while using the optimal shielding mechanism.

3. MATERIALS AND METHODS

Five hundred and nineteen (519) randomly selected patients who underwent angioplasty procedures were enrolled. AK (Air Kerma) and ST (Screening Time) as given by the machine in mGy and minutes respectively were collected for each case. The study was conducted from 1st June 2019 to 31st May 2022. The PCI procedures were conducted at a single center in a Cath lab installed with Phillips FD10 machine by a single cardiologist with a prior experience of performing > 3000 PCIs. Primary endpoint of the study was the comparison between our centre overall mean AK and ST data with overall mean AK and ST of selected ten studies from reputed journals. Secondary endpoint of the study was the comparison between our centre overall mean AK and ST data with overall mean AK and ST of each selected ten studies from reputed journals. We selected those studies where enhanced radiation reducing protocol in the cardiac catheterization laboratory was used. Out of nine studies, in one study the comparison was done through median AK. Another study has used air kerma to evaluate the operator dose reduction using AK. Out of the ten studies, only six has mentioned their ST data. The AK and ST data of all the ten studies are shown in Table 1.

Table 1: The AK and ST data of all the ten studies.

Study	**Non enhanced safety protocol**		**Enhanced safety protocol**	
	No of Patients	**Mean/ Median AK in** mGy	**No of Patients**	**Mean/ Median AK in** mGy
Gutiérrez-Barrios A, et al. [1] Effective Reduction of Radiation Exposure during Cardiac Catheterization.	85	687 ± 748	85	379 ± 379
Gupta A, et al. [2] Radiation Exposure Reduction and Patient Outcome by Using Very Low Frame Rate Fluoroscopy Protocol (3.8 + 7.5 fps) During Percutaneous Coronary Intervention.	193	1,714 ± 140	133	433 ± 27
Werner GS, et al. [3] Modulated radiation protocol achieves marked reduction of radiation exposure for	366	2,040 (1,321-3,339)	186	655 (415-1,113)

chronic total coronary occlusion intervention.				
Werner GS, et al. [4] Reducing Fluoroscopic and Cineangiographic Contribution to Radiation Exposure for Chronic Total Coronary Occlusion Interventions.	183	2619 (1653-4574)	238	746 (480-1225)
Bhat KG, et al. [5] "Minimizing scattered radiation dose in cardiac catheterization laboratory during interventional procedures using lead free drape–MILD study."	70	2019 ± 1449)		
Busse T, et al. [6] Influence of novel X-ray imaging technology on radiation exposure during chronic total occlusion procedures.	98	966.8	98	675.9
Agarwal S, et al. [7] Relationship of beam angulation and radiation exposure in the cardiac catheterization laboratory.	755	2188 (Median)		
Wassef AW, et al. [8] Radiation dose reduction in the cardiac catheterization laboratory utilizing a novel protocol.	129	1610	122	860
Faroux L, et al. [9] Minimizing exposure to radiation in invasive cardiology using modern dose-reduction technology: Evaluation of the real-life effects.	1146	409	949	313

4. RESULTS

We selected those studies where enhanced radiation protection in the cardiac catheterization laboratory was used. The mean AK from our cohort when compared to other published studies was significantly lesser than six studies and higher than one study. The mean of all the AKs reported in eight studies was 1146 mGy ± 768 mGy compared to our mean AK of 611 mGy ± 469 mGy. The mean AK of one study was 2019 mGy ± 1449 mGy which was significantly higher than our mean AK. When compared with enhanced radiation safety protocol cohort, our mean AK was lesser than four centers and more than two centers. The mean AK of all AKs reported in six studies was 456 mGy ± 205 mGy which was less compared to our mean AK. The median AK in our study cohort was 491 mGy compared to one study (755 angioplasty procedures) in which the median AK reported was 2188 mGy.

5. DISCUSSION

In a study, Gutiérrez-Barrios A, et al. [1] showed that fine-tuning the radiation protocol reduces Air Kerma and Dose Area Product in the cardiac catheterization laboratory. These dose reductions were achieved without increasing the volume of contrast media, fluoroscopy time, or rates of procedural complications, and without reducing the productivity of the laboratory. Gupta A, et al. [2] proposed that Very Low Frame Rate Fluoroscopy Protocol and Increasing use of fluoroscopic storage in place of cineangiography reduces Air Kerma. These dose reductions were achieved without increase in the fluoroscopy time, contrast volume. In a study, Werner GS, et al. [3] show that low fluoroscopy frame rate, low cine frame rate, increased copper filtering with lower entry dose in combination with a modified image postprocessing reduces Air Kerma and Dose Area Product in the cardiac catheterization laboratory. These dose reductions were achieved without increase in the fluoroscopy time. In another study Werner GS, et al. [4] proposed that by modifying both the fluoroscopic and cineangiography contribution reduces Air Kerma and Dose Area Product. Bhat KG, et al. [5] proposed that, usage of RADPAD DRAPE will reduce Air Kerma, Dose Area Product and Cine Adjusted Screening Time. In a study, Busse T, et al. [6] show that use of the novel X-ray imaging technology compared to use of its predecessor will reduce Air Kerma, Dose Area Product in the cardiac catheterization laboratory. Agarwal S, et al. [7] proposed that, small increases in steepness of the angulation will increase Dose Area Product. Wassef AW, et al. [8] show that novel radiation reduction protocol was decrease in FPS in cine and fluoro to achieve reduction in radiation doses inside cardiac catheterization laboratory. Faroux L, et al. [9] proposed that dose-reduction technology is used in one of the imaging systems out of two imaging system studied.

In our study, we found that when compared with non-enhanced radiation protection cohort mean AK from our cohort is significantly lesser than six studies and higher than one study. When compared with enhanced radiation safety protocol cohort, mean AK from our cohort is significantly lesser than four studies and higher than two study. This reduction was achieved using Fluoro save instead of CINE, use of contrast checks to ascertain quickly in place of full contrast injection and recordings, non-use of fluoroscopy while the hardware is still in the tubing (ascertained by the length of the wire/balloon/stent outside the delivery system), short cines over long cine recordings routinely except for visualization of cardiac veins, avoiding foot on the pedal syndrome while awaiting fixing of hardware outside the delivery system.

6. CONCLUSION

Optimizing the radiation safety protocol effectively reduces radiation exposure in patients and operators during cardiac catheterization procedures.

7. CONFLICT OF INTEREST

Nil

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