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ORIGINAL RESEARCH

Estimation of Radiation Exposure received by Radiation Health Workers from the patients undergoing Myocardial Perfusion Imaging

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Abstract

Background: The Myocardial Perfusion Imaging study, whether performed in a single-day or dual-day protocol, is a potential source of radiation exposure to radiation health workers carrying out the procedure. In this study, we tried to compare and find out which protocol results in lesser radiation exposure to RHW keeping in mind the principle of as low as reasonably achievable and hence can be the preferred one in routine clinical practice. A total of 53 patients participated in the study. It was divided into two different groups: Group A comprising 34 patients undergoing dual-day protocol and Group B comprising 19 patients undergoing single-day protocol respectively. The radiation exposure rate was recorded at 30cm, 50cm, and 100cm immediately post-injection and at a distance of 100cm at 1hour and 2hour post-injection using an ionization-based survey meter.

Results: We observed that radiation health worker carrying out the procedure receives lesser radiation exposure in the dual-day protocol setting as compared to the single-day protocol setting. If single-day protocol is performed then the stress part should be performed first because it gives a lesser radiation exposure rate. This is more so pertinent in the case of performing pharmacological stress myocardial perfusion imaging, where the distance between radiation health worker and patient is relatively less when compared to the physical stress setting done on a treadmill.

Conclusion: Furthermore, the significance of a reduction in radiation exposure rate with time and distance is reinforced as a key radiation safety principle.

Key words: Myocardial perfusion imaging, radiation exposure rates, Radiation health worker

Background

Radiation protection aims to reduce unnecessary radiation exposure with the goal of minimising the stochastic and deterministic effects of ionising radiation.[1-2] Myocardial Perfusion Imaging (MPI) using Single Photon Emission Computed Tomography (SPECT), whether performed in a single-day (SDP) or dual-day protocol (DDP), is a potential source of radiation exposure to radiation health workers (RHW) carrying out the procedure. The radiation exposure rate (RER) from patients administered with 99mTc-Sestamibi is significant from the radiation protection point of view in the first few hours after injection. There are lot of studies available regarding radiation exposure to patients undergoing MPI

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scanning [3–8, 13], but very few studies which have been done measuring radiation exposure to RHW carrying out the procedure. Hence, this present study was undertaken to measure the radiation exposure to RHW from injected patients who underwent MPI procedure and also compare the RER in two MPI protocol settings as mentioned above.

Methods

This prospective study was done on patients referred for MPI scanning in the Department of Nuclear Medicine at Guru Gobind Singh Medical College and Hospital, Faridkot who gave written consent to participate in the study. The MPI scanning was performed using a SPECT/CT (Philips Bright View XCT) camera using 99mTc labelled Sestamibi radiopharmaceutical. Radiation exposure was measured with a portable Ionization Chamber based radiation survey meter (RAM ION DIG MODEL-BAK 1940).

We divided patients into two groups: Group A: who underwent MPI in DDP and Group B: who underwent MPI in an SDP setting. Activity administered in 1st and 2nd study parts of SDP was 296 MBq and 1110 MBq respectively where as patients in both study parts of DDP received 296-370 MBq each. The sequence of rest/stress or stress/rest was decided on the basis of the clinical history of the patient.

The radiation exposure rate was measured at chest level using an Ionization Chamber (IC) based survey meter, immediately after injection at 30 cm, 50 cm, and 100 cm from the injected patients, and then at 1 hour and 2 hours post injection at a distance of 100 cm from the injected patients. From recorded observations, mean RER was calculated and a student t-test was applied to statically analyse the data.

Results

A total of 53 patients comprising of 38 males (age range: 35-78 yrs; mean age: 60.71 yrs) and 15 females (age range: 42-71 yrs; mean age: 56.06 yrs), were included in the study. Group A included 34 patients who underwent MPI in a DDP setting (27 males and 7 females), whereas in Group B included 19 patients underwent MPI in a SDP setting (11 males and 8 females).

A statistically significant difference ($p<0.001$) was observed on comparing RER of both groups at 30, 50, and 100 cm immediately post-injection and likewise on comparing RER of both groups at 100 cm immediately with 1 hr post-injection. (Table 1-3)

Table 1: The mean RER in the 1st and 2nd study stress/rest or rest/stress parts of Group A measured at various distances and time intervals is summarised in Table 1

		Mean±SD of radiation exposure rate in (µSv/hr) of Group A	
		1st study part	2nd study part
Immediately after injection patients	at 30cm	15.58±0.84	15.6±0.67
	at 50cm	11.77±0.64	11.65±0.46
	at 100cm	8.14±0.67	8.55±0.48
At 100cm distance from the injected patients	at 1hr	7.68±0.54	7.77±0.45
	at 2hrs	7.45±0.47	7.42±0.42

Table 2: The mean RER in the 1st and 2nd study parts of Group B, measured at various distances and time intervals were summarised in Table 2.

		Mean±SD of radiation exposure rate in (µSv/hr) of Group B	
		1st study part	2nd study part
Immediately after injection patients	at 30cm	15.05±0.54	46.53±1.21
	at 50cm	11.68±0.84	31±0.75
	at 100cm	9.47±0.71	19.82±0.82

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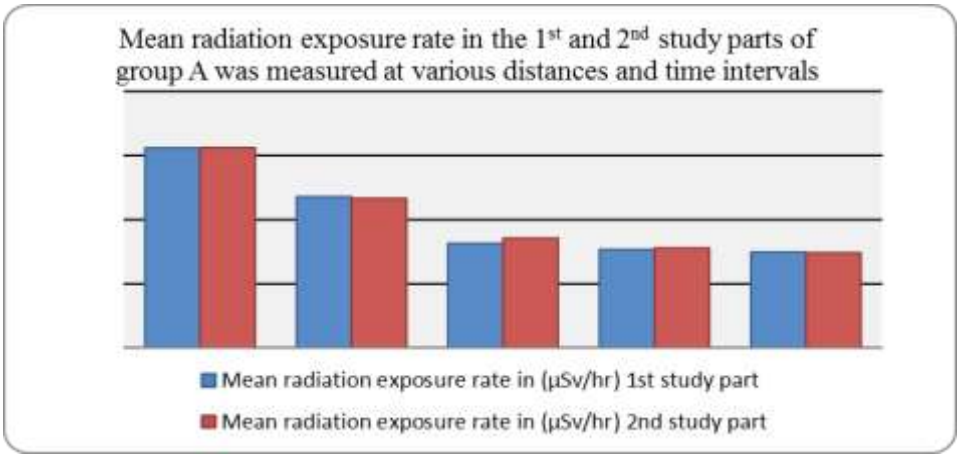
At 100cm distance from the injected patients	at 1hr	8.86±0.61	14.02±0.56
	at 2hrs	8.5±0.67	13.79±0.59

Table 3: The mean RER in the 1st and 2nd study parts of Group A patients was compared with Group B patients is shown in Table 3

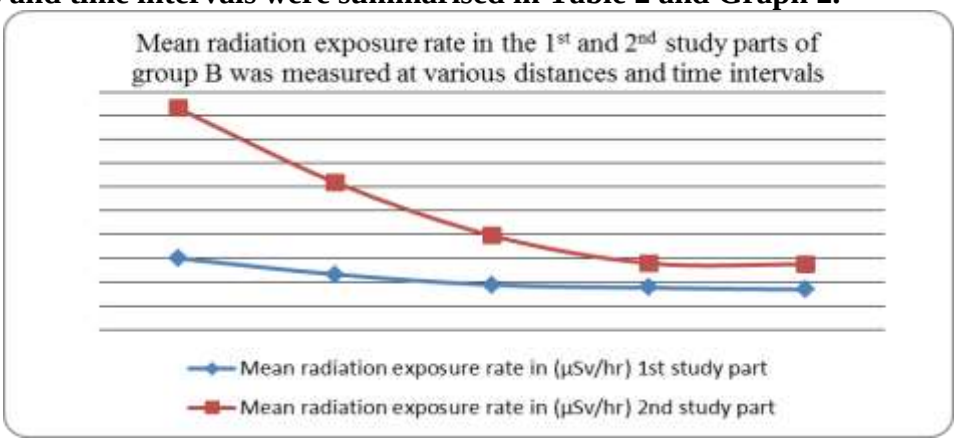
		Mean radiation exposure rate in (µSv/hr) of Group A and B			
		1st study part		2nd study part	
		DDP	SDP	DDP	SDP
Immediately after injection patients	at 30cm	15.58	15.05	15.6	46.53
	at 50cm	11.77	11.68	11.65	31
	at 100cm	8.14	9.47	8.55	19.82
At 100cm distance from the injected patients	at 1hr	7.68	8.86	7.77	14.02
	at 2hrs	7.45	8.5	7.42	13.79

However, no statistically significant difference was observed on comparing the RER at 100 cm in both groups after 1 hr & 2 hr post injection. (Graph 1-3)

Graph 1: The mean RER in the 1st and 2nd study stress/rest or rest/stress parts of Group A measured at various distances and time intervals is summarised in Table 1



Graph 2: The mean RER in the 1st and 2nd study parts of Group B, measured at various distances and time intervals were summarised in Table 2 and Graph 2.



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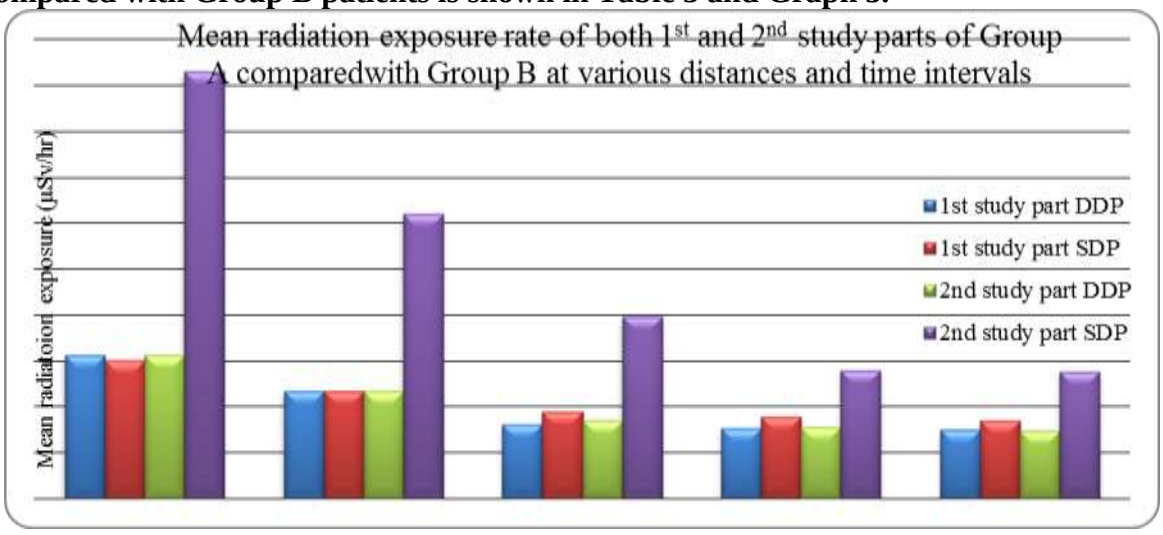
Graph 3: The mean RER in the 1st and 2nd study parts of Group A patients was compared with Group B patients is shown in Table 3 and Graph 3.



Discussion

The MPI is done for the prognostication of various heart diseases to evaluate cardiac perfusion and function in rest and stress conditions.[2] In the literature, various authors have reported a male preponderance pattern in cardiac-related diseases in their respective studies.[5,8,13–14] A similar incidence of male preponderance was also seen in our study, with 38/53 patients (71.70%) being males. The mean age of patients in our study was 59.39 years, which was in accordance with the mean age of presentation mentioned in various studies. [13,15]

In our study, 34 out of 53 patients underwent MPI in the DDP setting and 19 patients in the SDP setting. This is because the DDP allows for more efficient use of radioactivity available on that given day in terms of the number of scans performed (both cardiac and non-cardiac studies), especially in a department having a heavy patient load. Furthermore, there is lesser radiation exposure to patients in a DDP setting considering overall lower amount of activity that is injected into patients. A finding consistent with reported literature evidence.[3-5, 8, 13]

From the above observations and comparing both study parts of group A with group B, it is clear that as the distance between injected patients and RHW increases, there is a significant reduction in RER in both the study parts of group A and B. A similar trend of a reduction in radiation exposure rate with an increase in distance has been mentioned in the literature by various authors in their respective studies.[3-4,6]

As sestimibi is continuously extracted by the myocardial cells, with peak extraction occurring by 45-50 min post injection, a significant reduction in RER occurs when comparing immediate to 1 hour readings in both the 1st and 2nd study parts of both groups at 100 cm. However, no statistically significant difference was observed in RER when comparing 1 & 2 hours at 100 cm readings due to the fact that the half-life of 99mTc is 6 hours and there is no significant decay between 1 and 2 hours.

No statistically significant difference is observed in comparing the mean RER of the first study part of DDP to that of SSP for a near similar amount of administered activity (293–370 MBq of both protocols). On the other-hand in 2nd study part of a SDP the injected activity is approximately three times i.e. 888 –1110 MBq that of the activity given in the 2nd study part of a DDP. Thus, a statistically significant difference was found in the mean RER of the 2nd study part of both protocols.

However, direct comparison of the mean RER from injected patients recorded in our study with that mentioned in literature was not possible. This may be attributed to the use of

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different equipment to measure radiation exposure rates, variation in dose administered, and different distances and time intervals.

Conclusions

In this present study, we concluded that the dual-day protocol setting is better than the single-day protocol setting on the basis of RER to RHW from the injected patients. We also recommend that the stress part of the MPI should be performed first in a SDP as far as clinically possible in order to minimise the radiation exposure to the RHW. This is especially important when performing pharmacological stress, as the second study part due to the time spent in close proximity to the injected patient.

List of abbreviations

1. MPI= Myocardial Perfusion Imaging
2. SPECT= Single Photon Emission Computed Tomography
3. SDP= Single-day protocol
4. DDP= Dual-day protocol
5. RHW= Radiation health workers
6. RER= Radiation exposure rate
7. MBq = Mega Becquerel
8. IC= Ionization Chamber

Competing interests

No conflict of interest

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