International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

Original Research Article.

Comparing Radiation Exposure to Radiation Health Workers (RHW) From the Patients Undergoing Myocardial Perfusion Imaging (MPI) In a Single Day Protocol

Bhavay Sonik[1], Kamaljit Singh[2], Amandeep Kaur[3], Alok Kumar Yadav[3], Ripudaman Brar[4], Shamim Monga[5]

[1]Assistant Professor, [2]M.Sc. Student, [3]Medical Physicist, [4]Consultant,
Department of Nuclear Medicine, Guru Gobind Singh Medical College and Hospital, Faridkot, Punjab, India.
[5]Assistant Professor,
Department of Community Medicine, Guru Gobind Singh Medical College and Hospital, Faridkot, Punjab, India.

ABSTRACT

The Myocardial Perfusion Imaging (MPI) study is performed with ^{99m}Tc labeled radiopharmaceuticals such as Sestamibi or Tetrofosmin in a single day or dual day protocol. Sequence of Rest/Stress or Stress/Rest depends upon clinical indication and departmental logistics. In this present study, we evaluated the radiation exposure received by the Radiation Health Worker (RHW) standing in the close proximity of the injected patients while performing rest and stress part of the MPI scan in a single day protocol setting.

Radiation exposure was measured immediately, at 1 hour and 2 hours post injection at a distance of 1 meter from injected patients using Ionization chamber based portable radiation survey meter.

A total of 69 patients were referred for ^{99m}Tc-Sestamibi MPI study to our department from the period Feb 2019-Jan 2021. Out of these 69 patients, 19 patients underwent MPI scanning in single day protocol. These patients were divided into 2 groups: Group A and Group B.

Group A included 13 patients and underwent rest followed by stress part of the MPI study. Mean radiation exposure from the patient to RHW measured immediately after injection, at 1 hour & 2 hours post injection was 9.33µSv/hr, 8.75µSv/hr, 8.52µSv/hr and 20.02µSv/hr, 14µSv/hr, 13.77µSv/hr during rest & stress parts of study respectively.

Group B included 6 patients and underwent stress followed by rest part of the MPI study. Means radiation exposure from the patient to RHW measured immediately after injection, at 1 hour and 2 hours post injection was 9.8µSv/hr, 9.13µSv/hr, 8.75µSv/hr and 19.4µSv/hr, 14.08µSv/hr, 13.85µSv/hr during stress & rest parts of study respectively.

It was observed during the present study, that maximum radiation exposure to RHW occurred in the 2nd part of MPI study in a single day protocol setting. Thus, we recommend that stress part of the MPI study should be performed first as far as clinically possible in order to minimize the radiation exposure to the RHW.

Keywords: Myocardium Perfusion Imaging, Radiation Exposure, Radiation Health Worker.

***Correspondence to:**

Dr. Shamim Monga,
Assistant Professor,
Department of Community Medicine,
Guru Gobind Singh Medical College and Hospital,
Faridkot, Punjab, India.

Article History:

Received: 06-03-2021, **Revised:** 01-04-2021, **Accepted:** 27-04-2021

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2021.7.3.017	

INTRODUCTION

Myocardial perfusion Imaging (MPI) using Single Photon Emission Computed Tomography (SPECT) is a well-established, highly standardized test to detect haemodynamically significant Coronary Artery Disease (CAD).[1] MPI studies are performed with ^{99m}Tc-Sestimibi which is short-lived radionuclide and the benefits of the diagnostic as well as prognostic information outweigh the risks of radiation exposure.[2-4] Despite the wealth of data regarding increasing radiation exposure to patients undergoing medical testing, limited data is available regarding radiation exposure to radiation health workers (RHW) undergoing MPI.[5-9] We therefore measured the radiation emitted by patients while undergoing MPI test and found that radiation exposure to people in close proximity to the patient in the first few hours after radioisotope injection may be important, particularly in individuals with repeated exposures

and/or in vulnerable populations. As expected, there was a large reduction in radiation exposure with small increases in distance from the patient, highlighting the importance of the effect of distance on radiation exposure, a key radiation safety principle. In this present study, we compared the radiation exposure received by the Radiation Health Worker standing in the proximity of the injected patients while performing rest and stress part of the MPI scan.

MATERIALS & METHODS

This prospective study was performed in the Department of Nuclear Medicine at Guru Gobind Singh Medical College & Hospital, Faridkot, Punjab between the period of Feb 2019–Jan 2021. Written consent was taken prior to enrollment of patients under the MPI scanning.

Patient Preparation

Depending on the indication for the MPI scanning and patient's history, medications such as Beta blockers, calcium channel blockers, Nitrates, Aminophylline and caffeine should be stopped 48-72hrs prior to the MPI scanning. Also, patient is asked to be fasting for 4 hours prior to MPI scanning.

Study Material

1. The MPI scanning was performed using SPECT/CT (Philips Bright View XCT) Camera.
2. ^{99m}Tc-Sestamibi kit was used for MPI scanning.
3. Administered dose in a single day protocol:
   1st study was 296-370MBq (8–10mCi)
   2nd study was 925–1110MBq (25–30mCi)
4. Radiation exposure was measured with portable Ionization Chamber based radiation survey meter (RAM ION DIG MODEL- BAK 1940).
5. The MPI study is performed with ^{99m}Tc labeled with Sestamibi in a Single day protocol. Sequence of Rest/Stress or Stress/Rest was performed on the basis of clinical history of patient and departmental logistics.

Methodology

In this present study, we evaluated the radiation exposure received by the RHW standing in the close proximity of the injected patients while performing rest and stress part of the MPI scan. The Radiation exposure rate was measured using an Ionization Chamber (IC) based Survey meter immediately, at 1 hour and 2 hours post injection at a distance of 1 meter from the patients.

We divided the patients into two different groups as:

- Group A: Patients undergoing rest study first followed by stress study
- Group B: Patients undergoing stress study first followed by rest study.

Statistical Analysis: Paired sample t-test was done to determine any significant difference in exposure rate from patients at above mentioned time intervals in both groups at a distance of 1 meter. meter.

Table 1: Radiation Exposure Rate in rest and stress part of study in Group A patients.

At 1 meter distance from the patients	Rest part (1st)		Stress part (2nd)	
	Range	Mean±SD	Range	Mean±SD
Immediately after injection	8.3-10.8	9.33±0.70	18.9-21.4	20.02±0.92
1 hr post injection	8.1-9.7	8.75±0.55	13.1-15.2	14±0.57
2 hr post injection	7.8-9.8	8.52±0.63	12.9-15.1	13.77±0.57

Graph 1: Radiation Exposure Rate in rest and stress part of study for each patient of Group A.

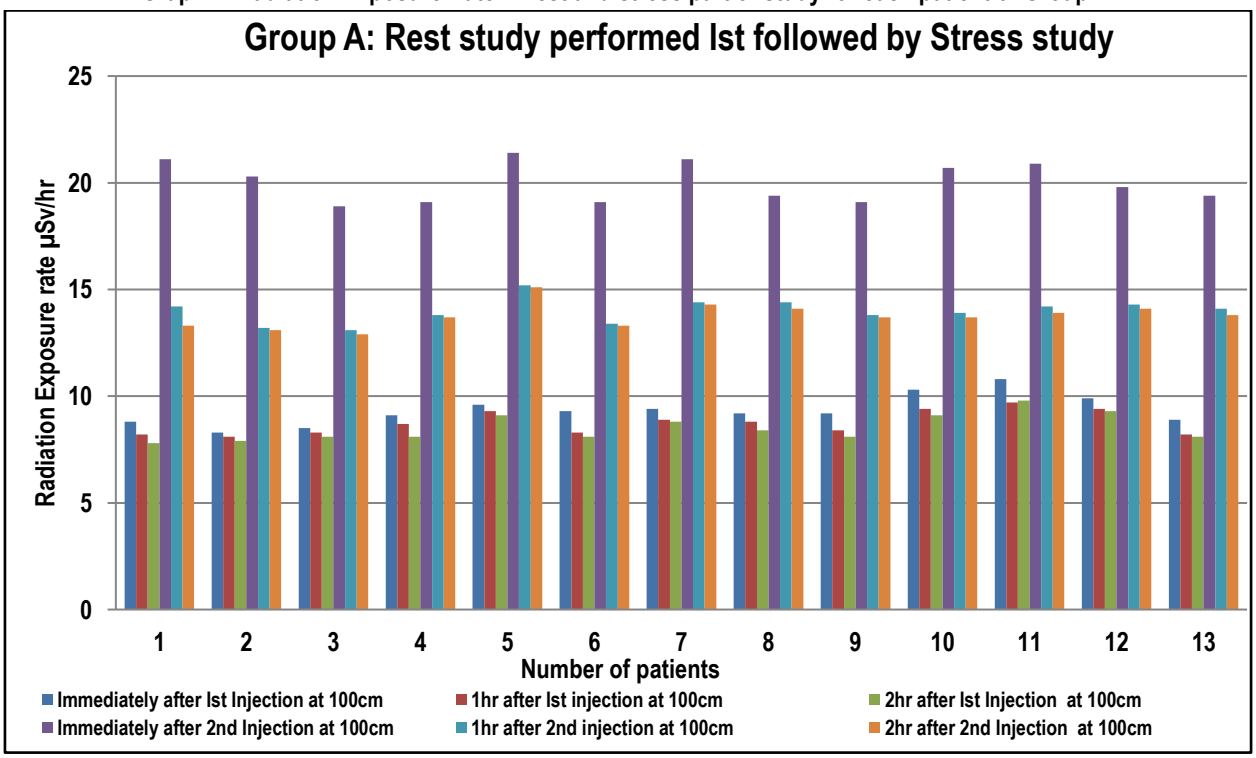
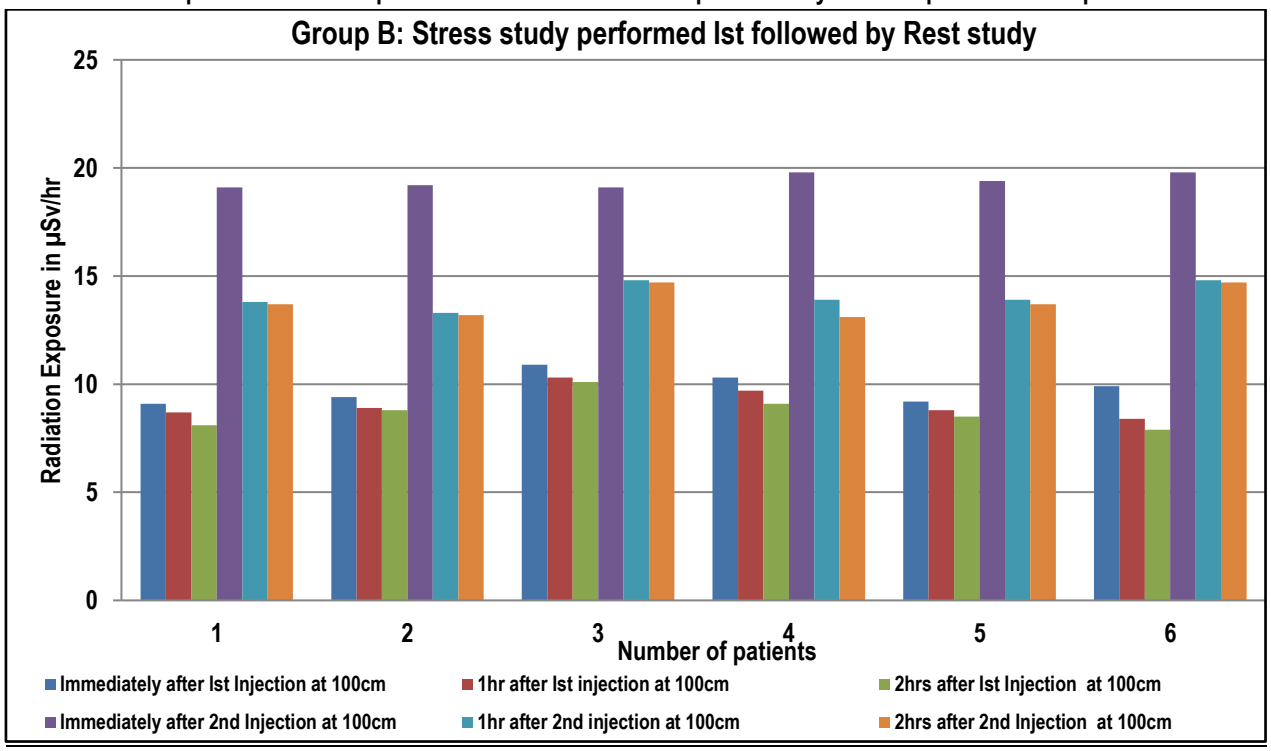


Table 2: Radiation Exposure Rate in stress and rest part of study in Group B patients.

At 1 meter distance from injected patients	Stress part (1st)		Rest part (2nd)	
	Range	Mean±SD	Range	Mean±SD
Immediately after injection	9.1-10.9	9.8±0.70	19.1-19.8	19.4±0.33
1 hr post injection	8.4-10.3	9.13±0.72	13.3-14.8	14.08±0.60
2 hr post injection	7.9-10.1	8.75±0.79	13.2-14.7	13.85±0.70

Graph 2: Radiation Exposure Rate in stress and rest part of study for each patient of Group B.



RESULTS & OBSERVATIONS

19/69 patients underwent Single day protocol; male: female – 11:9; mean age 60.75yrs.

Group A: It included 13 patients (males: females – 6:7).

The Radiation exposure from the patient to RHW measured immediately, at 1 hour and 2 hours post injection at the distance of 1meter in Group A as shown in Table 1 & Graph 1.

The Radiation exposure from the patient to RHW measured immediately, at 1 hour and 2 hours post injection at the distance of 1meter in Group B as shown in Table 2 & Graph 2.

Significant difference was observed in the exposure rate from patients to RHW when measured immediately, at 1 hour and 2 hours post injection at the distance of 1meter when comparing 1st study with the second study in both the groups (p value 0.0001) using paired t-test.

DISCUSSION

MPI is a highly efficient diagnostic and prognostic tool for patients suspected to have or diagnosed with coronary artery disease. It evaluates cardiac perfusion and function both at rest and stress (physical or pharmacological) conditions. In this present study, MPI was performed using single day protocol and injected dose in 1st study was 296-370MBq (8–10mCi) whereas in 2nd study was 925–1110MBq (25–30mCi). This was as per the guidelines recommend by European Association of Nuclear Medicine/ European Society of Cardiology (EANM/(ESC) in 2005. It stated that the injected dose in 2nd study of a single day protocol should be at least three times higher than that of the dose given for 1st study. Also, they recommended that the optimal time interval between the two studies should be more than two hours to avoid shine-through artifacts in the final image.[10,11]

Similarly, IAEA Nuclear Cardiology Protocols Cross-Sectional Study (INCAPS) also recommends that the 2nd injection dose should be three times or more than that of the first injection dose (i.e. injection dose ratio ≥ 3).[12] In addition, to reduce radiation doses by up to 80%, it was recommended that to perform stress-only protocols (without complementary resting scans) if clinically indicated. This was based on the understanding that post-stress phase or recovery phase is the most critical time point where RHW received the highest radiation dose and more so when stress is performed as 2nd study in a single day protocol setting.[12,13] In our department sequence of Rest/Stress or Stress/Rest was decided on clinical indication and availability of radioactivity as well as patient load. In MPI, patients is administered with radioactive pharmaceutical (^{99m}Tc-Sestamibi/^{99m}Tc-Tetrofosmin) that continues to emit gamma radiation, which causes potential radiation exposure to the patient undergoing MPI scanning and others standing near the proximate of the injected patients such as radiation workers, physicians, nursing staff and helpers.

Various studies done till date measure the radiation exposure of the patient undergoing MPI scanning.[14-24] but limited data is available which measures radiation exposure to radiation health workers standing in close proximity of the injected patients during

MPI. Majority of the studies had used Geiger Muller (GM) counters to measure the radiation exposure rate from injected patients to RHW.[25-28] As both IC and GM counters differ in relation to working principles, a meaningful comparison of exposure rate readings observed in our study with that of available literature is not possible. We know that the RHW has to stand in close proximity to the patient while performing physical/pharmacological stress before injecting radioactivity at peak stress level. Thus, the radiation exposure to RHW will be more when performing stress as 2nd part of MPI study on accounts of accumulated activity given to the patient and time needed to perform the stress study.

CONCLUSION

A Radiation Health Worker (RHW) receives maximum radiation exposure during the 2nd part of the MPI study in a single day protocol setting. Thus, we recommend that stress part of the MPI study should be performed first as far as clinically possible in order to minimize the radiation exposure to the RHW.

REFERENCES

1. Harvey AZ, Thrall JH, O Malley JP. Nuclear Medicine: The Requisites in Radiology. Philadelphia, Elsevier 2006; 3(14): 450-507.
2. Cremer P, Hachamovitch R, Tamarappoo B. Clinical decision making with myocardial perfusion imaging in patients with known or suspected coronary artery disease. Semin Nucl Med. 2014 Jul;44(4):320-9.
3. Fathala A. Myocardial Perfusion Scintigraphy: techniques, interpretation, indications and reporting. Ann Saudi Med 2011; 31(6): 625–34.
4. Strauss HW, Miller DD, Wittry MD, Cerqueira MD, Garcia EV, et al. Procedure Guideline for Myocardial Perfusion Imaging. J Nucl Med Tech 2008; 36(3):1.
5. Rigo P, Leclercq B, Itti R, Lahiri A, Braat S. Technetium-99m-tetrofosmin myocardial imaging: a comparison with thallium-201 and angiography. J Nucl Med 1994; 35(4): 587-93.
6. Kelly JD, Forster AM, Higley B, Archer CM, Booker FS, et al. Technetium-99m-tetrofosmin as a new radiopharmaceutical for myocardial perfusion imaging. J Nucl Med 1993; 34(2): 222-7.
7. Yoshinaga K, Manabe O, Tamaki N. Absolute quantification of myocardial blood flow. J Nucl Cardiol 2018; 25(2): 635-65.
8. Beanlands, Ruddy T.D, Bielawski L, et al. Differentiation of myocardial ischemia and necrosis by 99mTc-glucaric acid kinetics. J Nucl Cardiol 1997; 274–82.
9. Dahlberg ST. Assessment of myocardial perfusion with 99mTc: image is everything. J Nucl Cardiol 2009; 16(4): 493-6.
10. Hesse B, Tägil K, Cuocolo A, Anagnostopoulos C, Bardiés M, Bax J, et al. EANM/ESC procedural guidelines for myocardial perfusion imaging in nuclear cardiology. Eur J Nucl Med Mol Imaging. 2005;32(7):855-97.
11. Henzlova MJ, Duvall WL, Einstein AJ, Travin MI, Verberne HJ. ASNC imaging guidelines for SPECT nuclear cardiology procedures: Stress, protocols, and tracers. J Nucl Cardiol. 2016;23(3):606-39.
12. Einstein A, Pascual TN, Mercuri M, Karthikeyan G, Vitola JV, Mahmarian JJ, et al. Current worldwide nuclear cardiology practices and radiation exposure: result from the 65 country IAEA Nuclear Cardiology Protocols Cross-Sectional Study (INCAPS). Eur Heart J. 2015;36(26):1689-96.
13. Van Train KF, Garcia EV, Maddahi J, Areeda J, Cooke CD, Kiat H, et al. Multicenter trial validation for quantitative analysis of same-day rest-stress technetium-99m-sestamibi myocardial tomograms. J Nucl Med. 1994;35(4):609-18.
14. Taillefer R, Gagnon A, Laflamme L, Grégoire J, Léveillé J, Phaneuf DC. Same day injections of Tc99m methoxy isobutyl isonitrile (hexamibi) for myocardial tomographic imaging: comparison between rest–stress and stress–rest injection sequences. Eur J Nucl Med. 1989;15(3):113-7.
15. Duvall WL, Guma KA, Kamen J, Croft LB, Parides M, et al. Reduction in occupational and patient radiation exposure from myocardial perfusion imaging: impact of stress-only imaging and high-efficiency SPECT camera technology. J Nucl Med.2013;54(8):1251-7.
16. Kusmierek J, Płachcinska A. Patient exposure to ionising radiation due to nuclear medicine cardiac procedures. Nucl Med Rev Cent East Eur. 2012;15(1):71-4.
17. Einstein AJ, Weiner SD, Bernheim A, Kulon M, Bokhari S, et al. Multiple testing, cumulative radiation dose, and clinical indications in patients undergoing myocardial perfusion imaging. JAMA. 2010;17;304(19):2137-44.
18. Einstein AJ. Effects of radiation exposure from cardiac imaging: how good are the data? J Am Coll Cardiol. 2012;7;59(6):553-65.
19. Gupta A, Bajaj NS. Reducing radiation exposure from nuclear myocardial perfusion imaging: Time to act is now. J Nucl Cardiol. 2017;24(6):1856-59.
20. Dorbala S, Blankstein R, Skali H, Park MA, Fantony J et. al. Approaches to Reducing Radiation Dose from Radionuclide Myocardial Perfusion Imaging. J Nucl Med 2015; 56:592–9.
21. Fazel R, Krumholz HM, Wang Y, Ross JS, Chen J. et al. Exposure to low-dose ionizing radiation from medical imaging procedures. N Engl J Med. 2009;361(9):849-57.
22. Einstein AJ, Moser KW, Thompson RC, Cerqueira MD, Henzlova MJ. Radiation dose to patients from cardiac diagnostic imaging. Circulation;2007;116(11):1290-305.
23. Raff KM, Chinnaiyan DA. Radiation dose from cardiac computed tomography before and after implementation of radiation dose reduction techniques. JAMA;2009;301:2340-8.
24. Smith-Bindman R, Lipson J, Marcus R, Kim KP, Mahesh M. et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risks of cancer. Arch Intern Med. 2009;619(22):2078-86.
25. Gunay O, Sarıhan M, Yarar O, Abuqbeitah M, Demire K et al. Determination of radiation dose from patients undergoing 99mTc Sestamibi nuclear cardiac imaging. Int J Environ Sci Tech. 2019:5251–8.
26. Alramlawy S, Khalil MM. Effective radiation dose to staff members due to myocardial perfusion SPECT imaging: tracking the exposure from preparation to patient release. Radiat Prot Dosimetry. 2018;1;182(3):345-51.
27. Tsao CW, Frost LE, Fanning K, Manning WJ, Hauser TH. Radiation dose in close proximity to patients after myocardial perfusion imaging: potential implications for hospital personnel and the public. J Am Coll Cardiol. 2013:23; 62(4): 351-2.
28. Sattari A, Dadashzadeh S, Nasiroghli, G, Firoozabadi H. Absorbed radiation to the nuclear medicine nurses from patients administered 201Tl and 99mTc- MIBI. International Atomic Energy Agency (IAEA): IAEA. 2010; 1.

Source of Support: Nil. **Conflict of Interest:** None Declared.

Cite this article as: Bhavay Sonik, Kamaljit Singh, Amandeep Kaur, Alok Kumar Yadav, Ripudaman Brar, Shamim Monga. Comparing Radiation Exposure to Radiation Health Workers (RHW) From the Patients Undergoing Myocardial Perfusion Imaging (MPI) In a Single Day Protocol. Int J Med Res Prof. 2021 May; 7(3): 66-69.
DOI:10.21276/ijmrp.2021.7.3.017