ORIGINAL ARTICLE

TEMPORAL TRENDS IN EXPOSURE RATES FROM BONE SCAN PATIENTS: TIME ENSURES SAFETY

Salman Ali,[1] Maseeh uz Zaman,[1] Nosheen Fatima,[2] Khalil Khan,[1] Gufran Khan,[1] Noreen Hameed,[1] Sadaf Saleem,[1] S Mansoor Naqvi[1]

[1] Department of Radiology, Aga Khan University Hospital, Karachi, Pakistan
[2] Department of Nuclear Medicine, Dr Ziauddin Hospital, Karachi, Pakistan

PJR January - March 2015; 25(1): 18-21

ABSTRACT

BACKGROUND: Bone scintigraphy is one of the most frequently performed of nuclear medicine procedures and nuclear medicine technologists are prone to expose at time of administering the radiopharmaceutical and position the patient during imaging. The purpose of this research work was to find out the exposure rates from patients undergoing bone scan at various time interval after injection of radiopharmaceutical. **MATERIAL AND METHODS:** This was a prospective study conducted at Nuclear Medicine Section, Department of Radiology, Aga Khan University Hospital, Karachi from January 2015 till February 2015. After injection of radiopharmaceutical (700-740 MBq of Tc-99m MDP), exposure rates (milli-Roentgen/hour; mR/h) were estimated at 1 meter distance at 10 minutes (T0) and 1 hour (T1) after injection and time of leaving the department (T2). **RESULTS:** During the study period, 71 patients were accrued with a mean age of 54 ±17 years. Male: Female 51% : 49%. Mean dose of Tc-99m MDP injected was 705 ± 131 MBq intravenously. Mean exposure rates at 1 meter distance at T0, T1 and T2 were 13.103 ± 4.631, 10.980 ± 4.559 and 5.300 ± 3.186 mR/h respectively. There was a statistically significant temporal reduction in exposure rates which was 16% in 1st hour (T0 to T1) and 60% in next phase (T1-T2). **CONCLUSION:** We conclude that exposure rate at 1 meter from bone scan patients to nuclear medicine technologists at the time of imaging is significantly lower than at 1 hour after injection. To keep radiation exposure at minimum, NM technologists should adopt time and distance strategies of radiation protection.

Key words: Radiation exposure; bone scan; technologist; MDP

Introduction

Bone scintigraphy is one of the most frequently performed of nuclear medicine procedures around the world. The reasons for its popularity are its wide availability, cost effectiveness and its proven sensitivity. Technetium-99m-labeled methylene diphosphonates (MDP) is the most commonly radiopharmaceutical which accumulates rapidly in bone, and by 2-6 hours after injection, about 50% of the injected dose is in the skeletal system. The uptake mechanisms of diphosphonates have not been completely elucidated. Presumably they are adsorbed to the mineral phase of bone, with relatively little binding to the organic phase. The degree of radiotracer uptake depends primarily on two factors: blood flow and, perhaps more importantly, the rate of new bone formation.[1] The usual adult dose is 20-25 mCi of Tc-99m MDP injected intravenously and imaging is typically performed after 2-6 hours. This temporal gap between injection and imaging allows clearance of the radiotracer from the soft tissues, resulting in

Correspondence : Dr. Maseeh uz Zaman
Department of Radiology,
Aga Khan University Hospital,
Karachi, Pakistan
Tel: 34930051 - Ext.: 2020
Email: maseeh.uzzaman@aku.edu

Submitted 13 April 2015, Accepted 27 April 2015

a higher target-to-background ratio and improved visualization of bone. Skeletal detail can be further enhanced by encouraging patients to drink copious amounts of fluid after radiotracer injection. Nuclear medicine technologists come into close proximity with radiation sources, receiving radiation doses while performing procedures such as preparing and administering the radioisotope, positioning the patient on the scanner bed, monitoring the patient during data acquisition, removing the patient from the bed, and escorting the patient to the department.[2]

It is generally considered that a patient undergoing a bone scan is the major source of radiation exposure in a nuclear medicine department and contributes to annual dose limit of 20 mSv to a technologist.[3] The purpose of this research work was to find out the exposure rates from patients undergoing bone scan at various time interval after injection of radio-pharmaceutical.

Material and Methods

This was a prospective study conducted at Nuclear medicine Section, Department of Radiology, Aga Khan University Hospital, Karachi from January 2015 till February 2015. According to department protocol, patients who were scheduled for bone scan were asked to come with good hydration, after history taking and examination, 20-25 mCi of Tc-99m MDP was injected intravenously. After injection of radio-pharmaceutical, patients were requested to take 8-10 glasses of water and stay in hot waiting area and also encourage for frequent void to minimize urinary bladder dose. Whole body images were acquired 2 hour after injection and after completion of scanning patients were released with instructions to maintain hydration and keep distance from general public for next 6-10 hours. Exposure rates (milli-Roentgen/hour; mR/h) were estimated using dosimeter (ESM, FH 40 G-L, Germany) at 1 meter distance at 10 minutes (T0) and 1 hour (T1) after injection and time of leaving the department (T2).

Statistical Analysis: Data was analyzed by using commercially available packages the Medcalc® statistical software version 11.3.10 and statistical package for social sciences (SPSS version 17®). Demographic and stress test variables were pros-pectively collected for all patients. A two-tailed student t-test was used to compare continuous variables and a chi-squared test was used to compare categorical variables. P value <0.05 were considered significant.

Results

During the study period, 71 patients were accrued with a mean age of 54 ±17 years. Male: Female 51% : 49%. Mean dose of Tc-99m MDP injected was 705 ± 131 MBq intravenously. Mean exposure rates at 1 meter distance at T0, T1 and T2 were 13.103 ± 4.631, 10.980 ± 4.559 and 5.300 ± 3.186 mR/h res-pectively. Mean time patients stayed in nuclear medi-cine department was 179 ± 44 minutes (Tab. 1). There was a statistically significant temporal reduction in exposure rates (Fig. 1). Reduction in exposure rate from T0 to T1 was 16% while it reached up to 60% at T2 (time of release) with a significant p value. (Fig. 2).

Variable	n=71
Age in years (Mean ± SD)	54 ± 17
Gender (M:F)	36:35 (51%:49%)
Dose of Tc-99m MDP (Mean ± SD) MBq	705 ± 131 MBq
Exposure rate at 1 meter (mean ± SD) in mR/hr within 10 minutes	13.103 ± 4.631
Exposure rate at 1 meter (mean ± SD) in mR/hr at 60 minutes	10.980 ± 4.559
Exposure rate at 1 meter (mean ± SD) in mR/hr at discharge	5.30 ± 3.186
Average duration (mean ± SD) of discharge since injection in minutes	179 ± 44

SD=Standard deviation
MDP=MethyeleneDiphosphonate
MBq=Mega Becquerel
mR/hr= milli-Roentgen/hour

Table 1: Patients' demographic

Discussion

Over the last 02 decades the nuclear medicine community has become more cognizant about the radiation exposure due nuclear medicine procedures

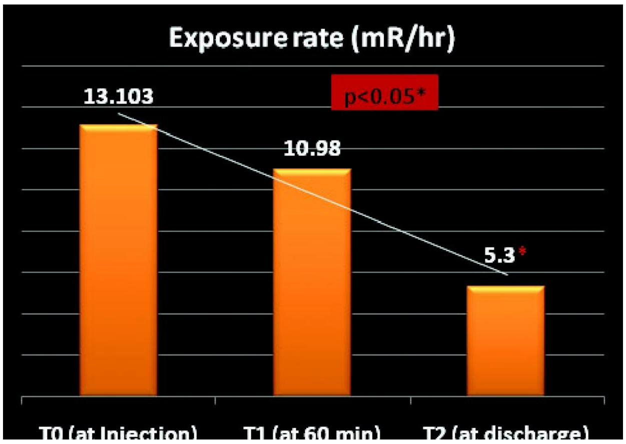

Figure 1: Comparative analysis of average exposure rates (mR/hr) at 1 meter distance within 10 minutes, 60 minutes of Tc-99m MDP injection and at discharge respectively

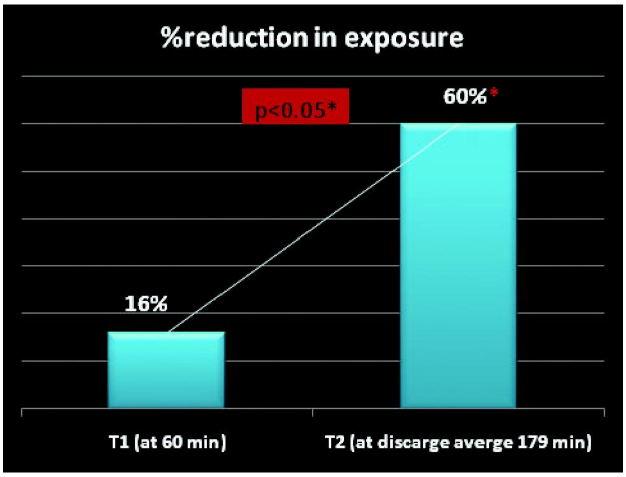

Figure 2: Illustrate % reduction in exposure rate after 60 minute of Tc-99m MDP injection and at discharge on average 179 minutes res.

as recently Einstein AJ et al,[4] revealed that about one-third of patients undergoing multiple myocardial perfusion imaging at a singlecenter received a cumulative estimated effective dose over 100 mSv, a level believed to be associated with an increased cancer risk. These data has also created concerns in general nuclear technologist about radiation exposures. As a matter of fact bone scan is the most commonly performed procedure with an average injected activity of around 740 MBq. Administering the radiopharmaceutical and positioning of patients under gamma camera are the two sources of exposure to nuclear medicine.[5]

This study shows that reduction in exposure rate in the 1st hour was 16% and during this time patients were used to stay in hot waiting area and do not expose the NM technologist. Importantly there was an exponential decline in exposure in next hour (T1-T2) which is 60% and this is the time when patients undergo for imaging and NM technologists have to come into close contact for positioning under the camera. The basic reason for this exponential fall is biological clearance of the tracer through kidneys. However, the time of close contact (about 1 m) is very brief as most of the existing cameras are provided with remote control system for gantry and bed movements. This provides NM technologist to adopt time and distance methodology of basic radiation protection principals. The success of this strategy is proved by results of quarterly measured radiation dose to our NM technologist which is very well below the statutory limits. This is to mention that AKUH is the only healthcare facility in country using Optically Stimulated Luminescent (OSL) method for dosimetry which is considered more sensitive than Thermo Luminescent Dosimetry TLD).6

We conclude that exposure rate at 1 meter from bone scan patients to nuclear medicine technologists at the time of imaging is significantly lower than at 1 hour after injection. To keep radiation exposure at minimum, NM technologists should adopt time and distance strategies of radiation protection.

References

1. McAfee JG, Reba RC, Majd M. The musculoskeletal system. In: Wagner HN, Jr, Szabo Z, Buchanan JW, eds. Principles of nuclear medicine. 2nd ed. Philadelphia, Pa: Saunders, 1995; 986-1012.

2. Seierstad T, Stranden E, Bjering K. Doses to nuclear technicians in a dedicated PET/CT centreutilising ^{18}F fluorodeoxyglucose (FDG). Radiat Prot Dosimetry. 2007; **123:** 246-9.

3. National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States: recommendation of the National Council on Radiation Protection and Measurements. Report No. 160, Bethesda, MD; NCRP, March 2009

4. Einstein AJ, Weiner SD, Bernheim A, Kulon M, Bokhari S, Johnson LL, et al. Multiple testing, cumulative radiation dose, and clinical indications in patients undergoing myocardial perfusion imaging. JAMA 2010; **304:** 2137-44.

5. Bayram T, Yilmaz AH, Demir M, Sonmez B. Radiation Dose to Technologists per Nuclear Medicine Examination and Estimation of Annual Dose. J. Nucl. Med. Technol. 2011; **39:** 55-9.

6. Zaman M, Fatima N, Naqvi SM, et al. Radiation dosimety: From Thermoluminisence (TLD) to optically stimulated dosimetr (OSLD). PJR July - September 2011; **21(3):** 107-09.