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Research Article

The Importance of Empty Bladder in Bone Scintigraphy Applications for Prevention of Radiation and Clinical Evaluation

Pelin Ozcan Kara[1]*, Serdar Sedat Isik[2], Gonca Kara Gedik[3] and Mustafa Cayci[4]

[1]*Faculty of Medicine, Department of Nuclear Medicine, Mersin University, Mersin, Turkey*

[2]*Faculty of Medicine, Department of Nuclear Medicine, Bilim University, Mersin, Turkey*

[3]*Faculty of Medicine, Department of Nuclear Medicine, Selcuklu, Selcuk University, Konya, Turkey*

[4]*Department of Nuclear Medicine, Konya Education and Research Hospital, Meram, Konya, Turkey*

***Corresponding Author:** Pelin Ozcan Kara, Associate Professor, Faculty of Medicine, Department of Nuclear Medicine, Mersin University, Mersin, Turkey.

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Abstract

Open radioactive sources are used in Nuclear Medicine applications. After the application of radioactive material to the patient, the patient himself becomes a radioactive source. For this reason, to take measures and careful implementation of the radiation protection for employees and other people come into prominence. Bone scintigraphy constitutes nearly one third of all nuclear medicine diagnostic applications. In this study, we aimed to investigate the effect of emptying bladder before scan on total radiation absorbed dose to the nuclear medicine technician on whole body bone scintigraphy.

Keywords: Empty Bladder; Bone Scintigraphy; Radiation

Introduction

The critical groups in terms of radiation exposure in nuclear medicine departments for both PET/CT and scintigraphy applications consist of nuclear medicine staff, patients and their caregivers. In all applications of radiation, radiation workers and the public can take maximum annual doses and should never be on the top of the doses specified by the ICPP 60 report [1]. For radiation applications, the maximum permissible dose is 50 mSv per year for radiation workers and is limited to a consecutive 5 year average of 20 mSv. This limit is 1 mSv for children and each individual. Nuclear medicine technicians sometimes exceeds 50 mSv dose limit and may be subjected to more dose [1,2]. In this study, we aimed to investigate the effect of emptying bladder before scan on total radiation absorbed dose to the nuclear medicine technician on whole body bone scintigraphy.

Materials and Methods

A total of 300 patients (156 men and 144 women, age range: 3 - 90, mean: 54.41 ± 19.49 year) who referred to our clinic for bone scintigraphy were included in the study. Whole body static or three phase bone scintigraphy were performed according to the patients' clinical history. Three-phase bone scan were performed in 80 of the 300 scans and static whole body bone scan were performed in the remaining 220 of 300. Five minutes and 3 - 4 hours after the iv injection of 20 mCi Tc^{99m} MDP, scans were obtained using the same gamma camera. Before the examinations of whole body and three phase bone scan, we measured the irradiation of environment at the level of the bladder from a distance of 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m while the bladder was full and empty, by using a Geiger–Müller probe.

Results

The average irradiation five minutes after the iv injection of Tc^{99m} MDP at the level of the bladder from a distance of 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m were 16.51, 6.64, 3.14, 1.56, 0.78 and 0.36 mR/hour, respectively. The same measurements 3 - 4 hours after the iv injection of Tc^{99m} MDP at the level of the bladder while the bladder was full from a distance of 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m were 24.05, 8.62, 4.08, 2.04, 1.04 and 0.58 mR/hour, respectively. After voiding, the same measurements at the level of the empty bladder from a distance of 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m were 8.07, 3.50, 1.74, 0.90, 0.48 and 0.24 mR/hour, respectively. According to these findings, as a result of emptying the bladder before bone imaging studies, nuclear medicine technicians are exposed to less radiation in a rate of 66.44%, 59.39%, 57.39%, 55.88%, 53.85% and 58.62% at 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m distances, respectively. In general, the technicians are protected from radiation with the average rate of 58.595%.

Whole body image of a 170 cm 13-year-old girl complaining pain in her joints is shown in Figure 1 a and b. Whole body imaging was performed while the bladder was full. During 14 minutes imaging, anterior and posterior total counts were 2596 and 1547 kilo counts from detector 1 and 2, respectively. After repeating the scan when the bladder is empty, the same counts from detector 1 and 2 were 978 and 634 kilo counts, respectively. Lesser counts were obtained after voiding with a rate of 62.3 % and 59 % from anterior and posterior images, respectively.

Figure 1: Bone images (a, b) whole body imaging with full bladder.

Whole body images of a patient with breast carcinoma (Figure 2 a and b), prostate carcinoma (Figure 2 c and d) and lung carcinoma (Figure 3 a and b) were illustrated. Multiple bone metastases can be seen in axial (vertebral column, ribs and sternum) and appendicular (pelvis and scapula) bones. In a communication by Clain A (3), pelvis and sacrum was found to be the second most common metastatic site with a percentage of 19.9 % of all metastatic sites. Pelvic bones are one of the common site of metastases. Therefore, correct imaging of pelvis is important. Imaging the bones of the pelvis of a patient with full bladder cannot be assessed due to the intense activity from bladder. Additionally, technician will be subjected to unnecessary radiation.

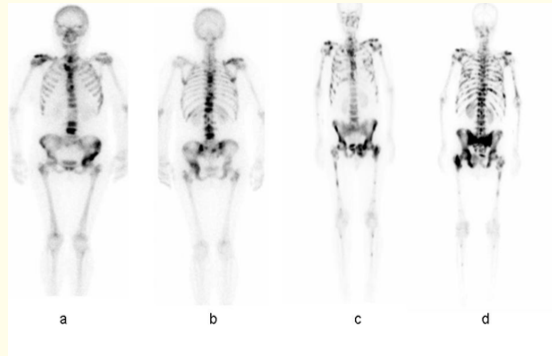

Figure 2: Bone images (a, b) multiple metastases in a breast cancer patient (c, d) multiple metastases in a prostate cancer patient.

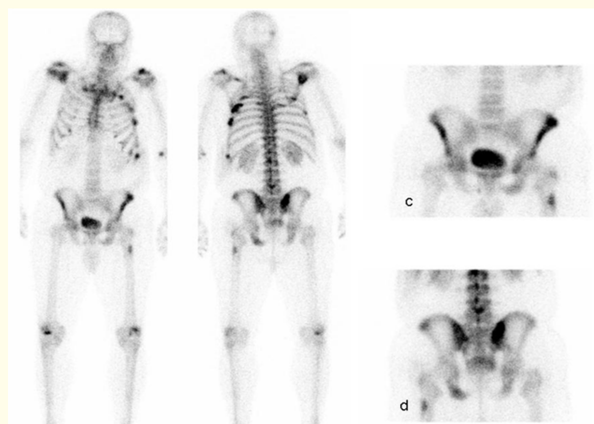

Figure 3: Bone images (a, b) multiple metastases in a lung cancer patient and (c, d) suspicious bone metastasis on pelvic spot image. Imaging with an empty bladder provides radiation protection and also provides to evaluate pelvic region more accurately.

Discussion

Radiopharmaceuticals are used for diagnostic and therapeutic purposes in Nuclear medicine clinics. Radioactive sources are used in Nuclear Medicine applications. Distance, time and shielding are the main important radiation protection principles. After the application of radioactive material to the patient, the patient himself becomes a radioactive source. For this reason, to take measures and careful implementation of the radiation protection for employees and other people come into prominence [4].

Tc^{99m} is the most commonly used radiopharmaceutical for diagnostic purposes in nuclear medicine applications. Myocardial perfusion imaging performed by using 20 mCi of Tc^{99m}-sestamibi and bone scintigraphy performed with an average of 20 mCi Tc^{99m}-MDP are the most common nuclear medicine procedures in various procedures giving a maximum activity. Therefore, whole body bone scintigraphy is one of the most common procedures from which the nuclear medicine technician exposed to radiation. Bone scintigraphy is performed with Tc^{99m} bisphosphonates [methylene diphosphonate (MDP) and hydroxy methylene diphosphonate (HMDP)] [5-7]. Bone scintigraphy constitutes, approximately 1/3 of all nuclear medicine applications. Radiographs of the bones allow the anatomical structure of bones whereas, a bone scan allows important physiological information in the evaluation of bone metabolism and blood flow. It provides great benefit in clinical terms because of its high sensitivity as well as providing to scan the entire skeletal system without an additional risk of radiation. Whole-body imaging technique is applied in the investigation of metastatic disease on standard bone scintigraphy. Blood flow and soft tissue are evaluated in addition to the involvement of bone on three-phase bone scintigraphy, which is mainly used in osteomyelitis and localized lesions such as tumors or fractures. Standard late static imaging and three-phase bone scintigraphy are the two protocols used in bone scintigraphy. Radiopharmaceutical (20 mCi Tc^{99m}-MDP) is injected intravenously to the patients at least 2-6 hours before the whole body bone scan. Radiopharmaceutical is injected in patients ongoing three-phase bone scintigraphy using a dynamic protocol, blood flow, blood pool images while lying supine under gamma camera and static images are taken 2 - 6 (average 4) hours after the dynamic images. In a study of three-phase bone scintigraphy images of blood flow can be taken from only one region (hip, thigh, knee, upper extremity, etc.). After 5 - 10 minutes, blood pool images should be obtained from the interested region and if necessary from other areas. This process is completed as soon as possible, and an average of 3 - 4 hours after injection, static whole-body images are taken. As a result of emptying the bladder before bone imaging studies, nuclear medicine technicians are exposed to less radiation in a rate of 66.44%, 59.39%, 57.39%, 55.88%, 53.85% and 58.62% at 0 m, 0.25 m, 0.50 m, 1.0 m, 1.5 m and 2.0 m distances, respectively. In general, the technicians are protected from radiation with the average rate of 58.595%. Although, distance, time and shielding are the main important radiation protection principles in Nuclear Medicine applications, according to our results a study with an empty bladder is an additional important parameter in radiation protection.

Conclusion

Distance, time and shielding are the main important radiation protection principles in Nuclear Medicine applications. According to current study results, a scintigraphic examination with an empty bladder is an additional important parameter in radiation protection. As a conclusion, medical applications with an empty bladder is simple but very important method in radiation protection.

Disclosures

All authors assert that there are no conflicts of interest (both personnel and institutional) regarding specific financial interests that are relevant to the work conducted or reported in this manuscript.

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