Investigation of Radiation Exposure Dose from Nuclear Medicine Procedures (Tc-99m MAG-3)

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Nuclear medicine is great for viewing the roles of body organs. Medical imaging in nuclear medicine takes radioactive pharmaceuticals and studies their path of progress through patient's body. The principles of nuclear medicine are different from those of diagnostic radiology. The nuclear medicine can study the functioning of body and how it actually works. On the other hand, usage of different kinds of radiopharmaceuticals in nuclear medicine examinations can affect the dose rates. The purpose of our investigation was to estimate the effective dose from most common procedures, performed in nuclear medicine departments. We noted the injection radiation doses, which are used for diagnosis in nuclear medicine clinics. Later patient radiation doses were calculated, according to models recommended in ICRP 106.

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1. Introduction

Over the past years, there has been an increase in the number of nuclear medical imaging procedures in hospitals that utilise the ionizing radiation. Although most of these procedures undoubtedly have benefits, there are others for which the benefit is not clear or has not been quantified. It is the duty of the referring clinician and the radiologist, cardiologist, and others to assess the potential benefit-risk ratio for various procedures. To do this, one needs to have some idea of the magnitude of the radiation dose associated with the procedures. This has recently been emphasized by the American College of Radiology [1].

Nuclear medicine uses radioactive materials in order to diagnose and treat diseases. The scans performed in the nuclear medicine, like gamma imaging, PET-CT (Positron Emission Tomography), are carried out by medical imaging technicians [2]. For nuclear medicine imaging, radioactive materials are combined with chemical compounds to create the radiopharmaceuticals. These created radiopharmaceuticals are given to patients by nuclear medicine nurses. Nurses play invaluable roles in the nuclear medicine, like in other clinics. The final state of the radiopharmaceuticals depends on how the targeted organ deals with the molecule, whether it is absorbed, broken down by intracellular chemical processes or whether it exits from the cells and is removed by bone, thyroid or kidney processes.

Such procedures of nuclear medicine are a safe, painless, and cost-effective way of gathering information. The advantages of nuclear medicine procedures are their

sensitivity to abnormalities in structure or function of organs. As an integral part of patient care, nuclear medicine is used especially in the diagnosis, treatment and prevention of serious disease.

2. Materials and methods

At the Department of Nuclear Medicine of Suleyman Demirel University, 25 patients were selected for this study during one month. These patients, who had received Technetium-99m (99mTc) MAG-3, during dynamic renal scintigraphy, were divided into age groups. For Tc-99m Mag3 we used routine radiopharmacy dose calibrator to calculate patient's radioactivity dose. Age distribution of the study groups is given in Table I.

TABLE I
Age distribution of patients, according to study groups.

Age groups	Num. of patients	Percentage [%]
≤ 7	9	42
8–17	4	19
≥ 18	8	39
Total	21	100

Tc-99m MAG-3 was given intravenously to adult patients and the amount of medicine was calculated according to their body weight, using parameters for children. The patients' age, weight and administered activity (mCi) were recorded. Analysis was performed to reveal the direction and functional status of the relationship of MAG-3.

3. Results and discussion

Renal scan is used to help to diagnose the kidney diseases and certain problems with the rest of the urinary

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tract. It is used at the same time to evaluate the function and the size of the kidneys. Our aim is to develop a method to predict the radiation doses of the organs of a specific patient, rather than use doses of a standard phantom. Radiation exposures from nuclear medical examinations are usually low and are almost always justified by the accurate diagnosis of the condition of possible disease. In this study, we present patients' organ doses after administration of ^{99m}Tc MAG-3 radiopharmaceutical.

It can be clearly seen in Figs. 1 and 2 that a good distribution of radiation dose has been obtained. Figure 2 shows the correlation between the administered activity of radiopharmaceutical (Tc-99m) and the weight of the patients.

Fig. 1. Relation between the administered activity (MAG-3) and the age of patients.

Fig. 2. Relation between the administered activity (MAG-3) and the weight of patients.

Fig. 3. Radiopharmaceutical (Tc-99m) correlation graph with weight/age.

Fig. 4. Relation between the patients' effective dose (MAG-3) and age.

Fig. 5. Relation between patients' effective dose (MAG-3) and weight.

TABLE II

Data for studied patients (procedure MAG-3).

Day	Gender	Age	Weight	Administered activity (mCi)	Estimated radiation dose (mSv) ICRP 106
1	F	46	70	4.3	1.4
1	F	57	80	4.5	1.5
1	M	15 month	10	1	0.3
1	M	5	14	1.3	0.3
1	F	7	32	2	0.7
8	F	42	68	4.7	1.6
8	F	17	50	4.3	1.4
8	M	31	90	4.9	1.3
15	F	15	47	3	1.0
15	M	1	4.5	1	0.3
15	F	11	35	2.5	0.8
15	F	14	50	3.3	1.1
22	M	5	20	1.5	0.4
22	M	38	70	4.1	1.1
22	M	22	56	3.6	0.9
22	F	32	98	3.8	1.3
29	M	2 month	5.5	0.7	0.2
29	M	2.5	11	1	0.3
29	F	5.5	17	1.2	0.4
29	M	7	28	2.1	0.5
29	M	2.5 month	4.5	0.5	0.1

Figures 1–3 show the activity distribution, based on data from Tables I and II. Figures 4 and 5 show the distribution of the effective dose of patients, based on data from Tables I and II.

Use of ^{99m}Tc -labeled compounds, such as mercaptoacetyltriglycine (MAG3), diethylenetriamine pentaacetic acid (DTPA), and dimercaptosuccinic acid (DMSA), has made kidney scintigraphy one of the most useful nuclear medicine tools [3, 4]. The imaging provided by each agent reflects different renal functional parameters [5, 6]. Although all of these methods accurately measure renal functional parameters, the agents do present some differences due to their distinct biological properties [7, 8], such as their renal excretion mechanisms, renal cell retention of radioactive material and bound plasma-protein and plasma clearance levels [9, 10].

This work was organised with the aim of providing our nuclear medicine clinic with the possibility of testing the performance of analytical methods on patients. Considering the measurements, a good compromise between the two results, obtained by our clinic has been ascertained. Such a comparison gives an opportunity to compare ones work and results and helps in evaluation of performance.

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