Evaluation of External Radiation Exposure of Personnel Who is Involved in Veterinary Nuclear Medicine

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Introduction

Veterinary nuclear medicine has been commonly performed in small animal and horse practice in US and EU countries. Since nuclear medicine is a technique that can be non-invasive, and can get both morphological and functional information on some particular target organs, needs to perform in veterinary medicine are also rapidly growing in Japan. However, prior to authorizing the use of radiopharmaceuticals for veterinary patients in Japan, although their methods are well-established and no serious radiation exposures were reported in veterinary medicine, it would be inevitable to evaluate the safety or human exposure to make guidelines for the safety use of radiochemical in veterinary practice. In this study, external radiation exposures are estimated concerning a human who is associated with a companion animal to which radiopharmaceutical is injected.

Materials and methods

A computer simulation program was used to estimate external radiation exposures of human in order to avoid the use of a number animal only for this purpose. In a preliminary study, the simulation program was based on a method of kerma and fluence rate according to the data published from the Nuclear Safety Technology Center (Tokyo). Monte Carlo method (EGS4) was also employed. Both of the calculated air absorption dose rates from a simple phantom source containing radioisotopes (^{18}F or ^{99m}Tc) were compared with the actually measured values. And the more practical calculations were considered by employing the information of internal organs and tissues of the body.

1. Measurement of the air absorption dose rates from a simple phantom

Columnar and spherical plastic phantoms were filled with tap water, and ^{18}F or ^{99m}Tc was injected into the phantom. The exposure was measured with the fluorescent glass dosimeters (Asahi Techno Glass Ltd.) that are assigned at particular distances around the phantoms. Then the measured values were corrected to air absorption dose rate (μGy/h) at time 0 of the RI injection into the phantom. The computer simulations were performed by a method of kerma and fluence rates, and by using EGS4.

2. Estimation of the air absorbed doses from the a complex phantom

Dog abdominal complex phantoms (small; 1kg, and Large; 30kg) with some particular organs were considered to imitate, according to the actual size and location of organs as described in a book of veterinary anatomy. The selected organs include the heart, muscle, bladder, kidney, lung, bone, liver, soft-tissue and the fat. It was hypothesized that injected radiopharmaceutical equally distributes only in the four organs (heart, liver, kidney, bladder). The air absorbed doses at the assigned distance from a surface of the dog abdominal phantom were calculated by EGS4.

Result and discussion

1. Comparison of air absorption dose rates

The obtained EGS4 values were almost comparable to the measured values. The calculation by using kerma and fluence rates was much different from the both of two values. However, in the EGS4 simulation, the statistical accuracy of ^{99m}Tc (Eγ; 141kev) was lower than ^{18}F (Eγ; 511kev). Since probability of the hit numbers to a target from a low energy source will be so low, the statistical accuracy of the obtained results might become lower. Further study is required to improve this statistical precision by selecting a better user code of EGS4.

2. Estimation of the air absorbed doses from the dog phantom

The calculation was performed by using personal computers with Windows XP operating system. Although it has two CPUs with two giga bytes memory, it takes ten days to finish calculation. The other results and discussion will be presented at this International EGS Workshop.