【Grant-in-Aid for Specially Promoted Research】
Science and Engineering (Mathematics/Physics)

Title of Project : Development of Medical Radionuclides Produced by Neutrons from Accelerator

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Research Area : Particle/Nuclear/Cosmic ray/Astro physics, Physical chemistry, Radiation science

Keyword : Nuclear physics (experiment), Accelerator technology, Chemical analysis by nuclear methods, Nuclear medicine, Radiopharmaceuticals/Contrast medium, Therapeutic radiology

【Purpose and Background of the Research】

In Japan, radiopharmaceuticals containing 99mTc, the daughter nuclide of 99Mo, and 90Y have been used for diagnostics (900,000 diagnostic procedures per year) and cancer therapy, respectively. Both 99Mo ($T_{1/2}$=66 h) and 90Y ($T_{1/2}$=64 h) are imported constantly. However, an unscheduled shutdown of reactors, which have been used to produce 99Mo by using highly enriched 235U, has caused a crisis shortage of 99Mo worldwide. 90Y decays during the transportation, which causes a problem in formulating 90Y-radiopharmaceuticals. 67Cu and 64Cu are believed to become central radioisotopes (RIs) for diagnostics and therapy. Establishment of practical production method of these RIs has been a longstanding problem.

Present study aims to produce 99mTc, 90Y, 64Cu and 67Cu by using only accelerator neutrons. Produced RIs can be separated from irradiated samples by physical and/or chemical processes. Radiopharmaceuticals containing the RIs are administered into animals to measure the bio-distributions of the RIs, which are compared with that obtained by using radio -pharmaceuticals containing existing RIs to prove the quality of the RIs produced by the proposed approach.

【Research Methods】

99Mo, 90Y, 64Cu and 67Cu are produced using neutrons provided at the Fusion Neutronics Facility of Japan Atomic Energy Agency. Carrier free 99mTc, 90Y, 64Cu and 67Cu can be obtained by sublimation or ion exchange chemical separation. Using the carrier free RIs, appropriate ligands are used among existing radiopharmaceuticals for labeling. Both accelerator neutron and reactor neutron produced 99mTc and 90Y, and accelerator neutron produced 64Cu and 67Cu are formulated as various radiopharmaceuticals for imaging studies. Their bio-distributions are assessed in a rat model to test the usefulness of the RIs produced by accelerator neutrons. In order to carry out the present study, high intensity accelerator neutrons are obtained by fabricating a large copper disk coated with titanium to absorb tritium. An automatic RIs processing system, which enables to separate a large amount of 99mTc and 90Y from irradiated samples and to recover enriched 100Mo and 90Zr samples with high efficiency, is installed.

【Expected Research Achievements and Scientific Significance】

We can establish basic technologies required to ensure a reliable and constant supply of 99Mo and supply a fresh and high quality 90Y in Japan. A novel production method of 64Cu and 67Cu in large quantities is for the first time established. Domestic production of these RIs would also contribute to reduce the escalating cost of human health care and should play an important role in new developments of radio -pharmaceuticals. Because of unique features of the newly proposed RIs production method, such as the use of accelerator neutrons (accelerator operates constantly and reliably), a small yield of radioactive waste, and the nonuse of highly enriched 235U, a facility for treating RIs and storing produced radionuclides can be made compact. Hence, the proposed method is accepted worldwide as being reliable and cost effective. Moreover, since many useful RIs for medical application can be produced by employing the proposed method, a new frontier of diagnostics and therapy in nuclear medicine is formed, which should contribute to foster young generation in a new research field.

【Publications Relevant to the Project】

1) Production of 99Mo for nuclear medicine by ^{100}Mo(n,2n)^{99}Mo, J. Phys. Soc. Jpn. 78 (2009) 033201-1, 033201-4
2) Production of an isomeric state of ^{90}Y by fast neutrons for nuclear diagnostics, J. Phys. Soc. Jpn. 78, (2009) 113201-1, 113201-4

【Term of Project】 FY2011-2014

【Budget Allocation】 299,200 Thousand Yen

【 Homepage Address and Other Contact Information】