Production of platinum radiotracer for Gamma-Ray Emission Imaging

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Platinum drugs such as cis-diammine dichloro platinum(Ⅱ) (cisplatin) have been used for a long time as a first-choice drug for several types of tumors. The efficacy of these types of drugs has been certainly approved however the disadvantages are the strong toxic side effects including nephrotoxicity, nausea, and neurotoxicity. These side effects are considered as dose-limitation factors. Further, in treatment, the tumor gradually develops resistance to these drugs. There are some mechanisms of resistance such as "Decreased uptake" and "Increased efflux." [1)]

To investigate potential side effects and drug efficacy, we are developing noninvasive and quantitative distribution analysis methods that can determine the concentration of platinum drugs in normal tissues/organs and tumors. We have propose using a new nuclear medicine imaging technology called GREI (Gamma-Ray Emission Imaging), to visualize the distribution of platinum drugs labeled with platinum radionuclides. GREI comprises a Compton camera composed of two planar germanium (Ge) detectors developed in our laboratory.[2)] GREI has a wide detectable energy range (200-2000 keV) which is different from the conventional imaging modalities, namely single photon emission computed tomography (SPECT) and positron emission tomography (PET). Next, a variety of nuclides that were difficult to image can now be used because of GREI.

For the GREI experiment, platinum radionuclides with optimum half-lives and emitting γ-rays are required. Some useful radionuclides for the GREI are listed in Table 1. In this study, we investigated the production of radio-platinum nuclides that are suitable for GREI experiments via the ^{nat}Os(α,xn) reactions.

For the radio-platinum production, we used metallic ^{nat}Os powder (chemical purity: 99.99 %) as the target material. Approximately 500 mg of osmium powder was pressed by 3 t at 1 min, and molded into a pellet (φ 15 mm). The pellet was covered with a 10-μm Al foil (chemical purity: 99.999%). The osmium target was irradiated by the 30-MeV α-beam supplied by RIKEN AVF cyclotron for 1.5 h. The beam intensity was 1 particle μA. The γ-ray spectrum of the irradiated target is shown in Fig. 1. This spectrum shows that ^{189}Pt and ^{191}Pt were produced, and fewer quantities of other impurities such as radio-osmium and radio-iridium were produced. After the irradiation, the following separation steps were performed to remove the target osmium from the radio-platinum as reported by M. Bonardi, et al.[3)] First, for removing osmium, the irradiated target was dissolved in 10 mL conc. HNO_3 and heated at the 200 ℃. In this step, osmium was distilled and trapped in 4.7 N NaOH. After almost all of the liquid was evaporated, another 10 mL of conc. HNO_3 was added and heated until dryness was achieved. After this step, the process of adding 5 mL of conc. HCl and drying up was repeated thrice. The reaction vessel was washed with 5 mL of 3 M HCl and the solution containing radio-platinum was transferred to a vial. After the chemical separation, the radioactivities of ^{189}Pt and ^{191}Pt were 0.48 and 1.0 MBq, respectively, and the chemical yield was over 90 %.

GREI can detect γ-rays of various energies that are emitted from ^{189}Pt and ^{191}Pt. This allows us to use both of these radio-platinum as radio tracers for imaging. In future, we will synthesize cisplatin with radio-platinum, administer it to a tumor-bearing mouse, and perform imaging experiments.

Table. 1. Useful platinum radionuclides for GREI.

Nuclide	Half-lives	γ-ray enegies and intensities (keV (%))
^{188}Pt	10.2 d	187.6 (19.4) 195.1 (18.6) 381.4 (7.5) 423.3 (4.4) 140.4 (2.3)
^{189}Pt	10.9 h	721.4 (9.3) 94.3 (7.6) 568.8 (7.1) 243.4 (7.0) 544.9 (5.8)
^{191}Pt	2.8 d	538.9 (13.7) 409.4 (8.0) 359.9 (6.0) 82.4 (4.9) 172.2 (3.5)

Data from IAEA

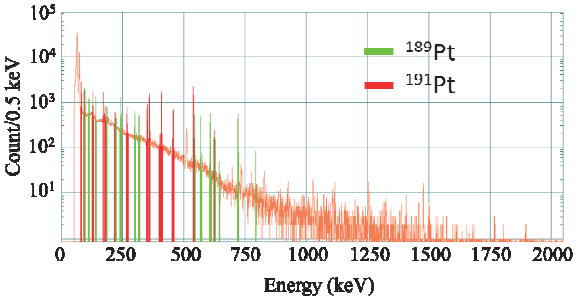

Fig. 1. Gamma-ray spectrum of produced nuclides in irradiated target.

References

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