【Grant-in-Aid for Scientific Research (S)】

Broad Section D

Title of Project： Whole gamma imaging to break through the physical limitation of positron emission tomography

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Keyword：PET, Compton camera, SPECT, nuclear medicine, scintillator

【Purpose and Background of the Research】

Positron emission tomography (PET), which uses a diagnostic drug labelled by a trace amount of weak radioactivity, has become a standard method for cancer diagnosis (figure 1), but PET does not make full use of detectable gamma-rays for imaging. Therefore, we aimed at replacing PET with whole gamma imaging (WGI), which is our original idea to utilize all detectable gamma-rays, for earlier diagnosis of intractable cancers such as multiple myeloma.

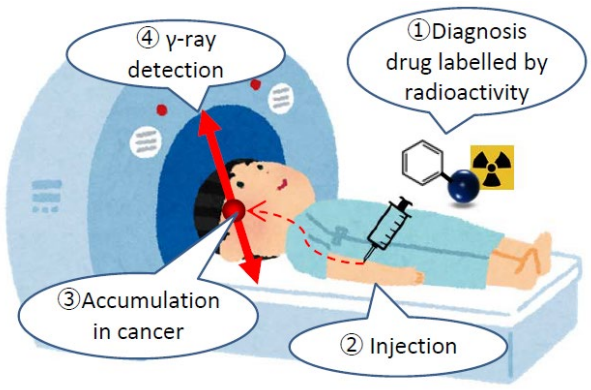

Figure 1 Schematic of the nuclear medicine imaging concept.

【Research Methods】

In WGI, an additional detector ring is inserted in a conventional PET ring so as to add a Compton camera function to a PET system. In addition to the coincidence detection of a pair of 511 keV photons, all other gamma-rays can be detected by means of the Compton camera, which localizes a radioisotope on a surface of a cone. Key methods to be studied in this project are (1) replacing a typical PET radioisotope such as ^{18}F (110 min half-life) in a radiopharmaceutical by an unusual radioisotope such as ^{89}Zr (3.3 d half-life), which emits a 909 keV gamma-ray in addition to a positron; (2) hybrid imaging of PET and Compton imaging; and (3) changing the principle of cancer diagnosis from glucose metabolism to an antigen-antibody reaction (figure 2).

【Expected Research Achievements and Scientific Significance】

There are three step-by-step goals in this project. First, a WGI system in which 909 keV Compton imaging shows better spatial resolution than PET will be developed. For this goal, a new scintillator which has better energy resolution than conventional PET scintillators will be developed. Second, a new imaging algorithm to combine both PET data and Compton imaging data will be developed so as to improve image quality. Third, diagnosis of multiple myeloma will be investigated as a clinical output of this project. Imaging demonstration of model mice will be done with the developed WGI system.

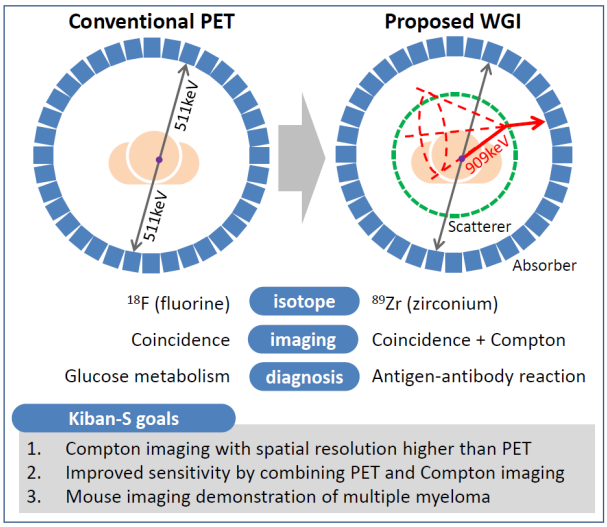

Figure 2 Schematic of whole gamma imaging (WGI) concept and the study.

【Publications Relevant to the Project】

- T. Yamaya, E. Yoshida, H. Tashima, et al., “Whole gamma imaging (WGI) concept: simulation study of triple-gamma imaging,” J. Nucl. Med., vol. 58, no. supplement 1, 152, 2017.
- E. Yoshida, H. Tashima, K. Nagatsu, et al., "Whole gamma imaging: a new concept of PET combined with Compton imaging," Phys. Med. Biol., 65, 125013, 2020.

【Term of Project】

FY2020-2024

【Budget Allocation】

151,900 Thousand Yen

【Homepage Address and Other Contact Information】

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