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In-vivo FXCT imaging of mouse brain

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Introduction

The fluorescent X-ray computed tomography (FXCT) with synchrotron radiation is being developed to depict the distribution of specific elements inside the object without slicing procedure [1-5]. FXCT system with a spatial resolution less than 0.1 mm and short data acquisition was constructed by using a germanium detector with high efficiency and high count-rate electronics [6]. In-vivo cerebral perfusion imaging of rat & mice has succeeded by FXCT after injecting non-radioactive iodine labeled cerebral perfusion agent (IMP) [7-10]. However, long time was required to acquire FXCT image data. For faster data FXCT imaging, we have improved scanning technique based on Compton scattering effect.

Methods and material

The experiment was carried out at the bending-magnet beam line BLNE-5A of the Tristan accumulation ring in Tsukuba, Japan. The photon flux rate in front of the object was approximately 9.3 x 10^7 photons/mm^2/s for a beam current of 40 mA. FXCT system consists of a silicon (220) double crystal monochromator, an x-ray slit system, a scanning table for subject positioning, fluorescent X-ray detector, and two pin-diode detectors for incident X-ray and transmission X-ray data. The white X-ray beam was monochromatized to 37 keV X-ray energy. The monochromatic X-ray was collimated into a 1 x 0.1 mm^2 pencil beam. Fluorescent X-rays were detected in a high purity germanium (HPGe) detectors and the HPGe detector was oriented perpendicular to the incident monochromatic x-ray beam. The data acquisition time of the HPGe detector for each scanning step was set 5-s. Object was scanned in 1-mm translation step and 6-degree rotation step over a range of 180 degrees.

In this experiment, Compton scatter was monitored simultaneously and used to determine the outside of object because Compton scattering signal becomes zero in the outside of object. Under the anesthesia, the brain of a mouse was imaged by FXCT after injecting non-radioactive iodine labeled IMP.

The present experiment was approved by the Medical Committee for the Use of Animals in Research of the University of Tsukuba, and it conformed to the guidelines of the American Physiological Society.

Results and discussion

In-vivo cerebral perfusion of mouse determined by the uptake of iodine content was clearly imaged by FXCT at a 1 mm spatial resolution with a 0.1 mm slice thickness. By using new scanning technique, the number of translation scanning step was reduced significantly, and data acquisition time was shortened to about 40%. Thus, we could obtain the image of two slices under the anesthesia, and the selection of better slice became easy to assess the disease condition. However, to perform much faster data acquisition, we are being developed new detector system with higher count rate capability.

In-vivo imaging of cerebral perfusion has succeeded by FXCT, and data acquisition time became shorter by using the new scanning technique.

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