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Cerebral perfusion imaging by fluorescent X-ray CT

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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 [1-6]. FXCT system with a spatial resolution less than 0.1 mm and short data acquisition was constructed by using two-germanium detectors with high efficiency and high count-rate electronics [7]. To examine the possibility of in-vivo FXCT imaging, cerebral perfusion imaging of a mouse was performed after injecting a non-radioactive iodine labeled cerebral perfusion agent (IMP).

Methods and material

The experiment was carried out at the bending-magnet beam line BLNE-5A of the Tristan accumulation ring (6.5 GeV) 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 (111) double crystal monochromator, an x-ray slit system, a scanning table for subject positioning, two fluorescent x-ray detectors with their X-ray collimator, 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 (horizontal and vertical, respectively). Fluorescent X-rays were detected in a high purity germanium (HPGe) detectors operating in the photon-counting mode 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 and 6-degree rotation over a range of 180 degrees. The 20-mm in diameter acrylic phantom filled with various concentration of iodine solution to determine the absolute content in biological object. Under the anesthesia, the brain of a mouse was obtained 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

Iodine inside the phantom and living mice brain were clearly imaged by FXCT at a 1 mm spatial resolution with a 0.1 mm slice thickness. Since good linear correlation was obtained between iodine content and fluorescent x-ray counts, iodine content within the brain was estimated. I-127 IMP cerebral perfusion image of a mouse was clearly shown by FXCT (Fig.1). The Iodine content in brain was about 0.01mg/ml. In-vivo FXCT imaging of cerebral perfusion has succeeded for the first time in the world. This result indicates that FXCT can be used as in-vivo bio-imaging of non-radioactive tracer material.

References

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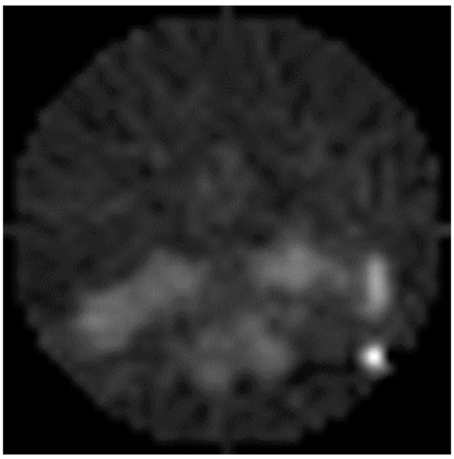

Figure 1 A I-127 IMP cerebral perfusion image of a mouse. C: The cerebellum of mouse.