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Fluorescent X-ray CT to depict specific element within biological object

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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 in the object without slicing the object[1-6]. Using two-detectors with high efficiency and high count-rate electronics, we constructed a new FXCT system with a spatial resolution less than 0.1 mm and with rapid data acquisition time. To predict the effectiveness of ^{131}I therapy in thyroid cancer, the cross sectional distribution of iodine within the thyroid cancer was examined by FXCT.

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 measured as approximately 9.3 x 10^7 photons/mm^2/s for a beam current of 40 mA by a pin-diode detector. The 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 a transmission x-ray detector (Fig.1). The white x-ray beam was monochromatized to 37 keV x-ray energy. The monochromatized x-ray was collimated into a 0.1 x 0.1 mm^2 or 0.025 x 0.025 mm^2 pencil beam (horizontal and vertical, respectively). Fluorescent x-rays were detected in a high purity germanium (HPGe) detector operating in the photon-counting mode and the HPGe detector was oriented perpendicular to the incident monochromatic x-ray beam. To get appropriate spatial resolution, the data acquisition time of the HPGe detector for each scanning step was set 5-s and 10-s, respectively. The object was thyroid cancer and adenoma with 10-mm in diameter.

Results and discussion

Iodine within phantom and thyroid gland were clearly imaged by FXCT at a 0.1 x 0.1 mm^2 spatial resolution with 0.1 mm slice thickness. Fig.2 shows a phantom filled with various concentration of iodine solution. The distribution of iodine was homogeneous in non follicular type thyroid cancer, whereas was heterogeneous in thyroid adenoma. Iodine content was estimated less than 0.1 mg/g. By this new system, data acquisition time was improved less than 1/2 of that by previous system.

References

1. Takeda T, Akiba M, Yuasa T, Akatsuka T, Kazama M, et al. SPIE 1996;2708: 685-695
2. Yuasa T, Akiba M, Takeda T, Kazama M, Hoshino Y, et al. IEEE trans. Nucl. Sci. 1997;44: 54-62
3. Rust GF, Weigelt J. IEEE Trans.Nucl.Sci. 1998; 45: 75-88
4. Takeda T, Yu Q, Yuasa T, Yashiri T, Zeniya T,et al. Nucl. Instr. Meth. 2001;A467-468:1318-1321
5. Yu Q, Takeda T, Yuasa T, Hasegawa Y, Wu J, et al. J. Synchrotron Rad. 2001;8: 1030-1034
6. Takeda T, Zeniya T, Wu J, Yu Q, Thet-Thet-Lwin, et al. SPIE 2001; 4503:299-309

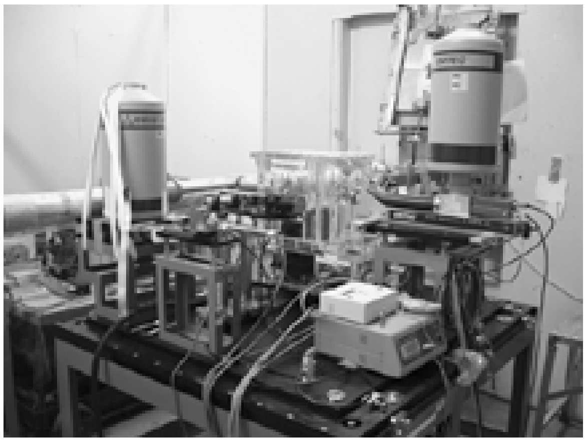

Fig.1 Picture of FXCT system

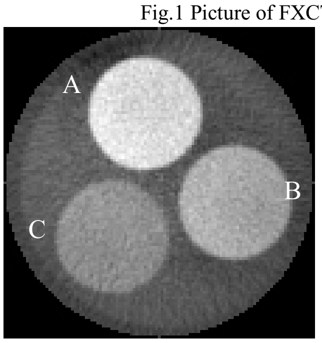

Fig.2 FXCT image of a 10-mm-in-diameter phantom with 3-holes. The 0005 mg/ml iodine solution are visualized clearly. A) 0.015 mg/ml, B) 0.010 mg/ml, C) 0.005 mg/ml.