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Small Animal Tumor Visualized by Three-Dimensional Phase-Contrast X-ray Computed Tomography

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1 Introduction

Currently used conventional X-ray CT images are generated from the differences in X-ray absorption. However biological soft tissue consisting of low atomic number such as H, C, N, and O, does not have enough X-ray absorption differences. Thus, high contrast resolution soft tissue image is required. Since cross section of X-ray phase shift is approximately 1000 times higher than that of absorption for low atomic numbers elements, phase-contrast X-ray CT enables to depict the internal structures of biological of soft tissue without contrast agents [1-5].

Here, we determine the feasibility to reveal the cancer morphology and its vascular structures in small animal tumors.

2 Experiment

This study used spontaneous development of brain tumor and testicular tumor of old rats (age, 2 years). Using two-crystal interferometer based phase-contrast X-ray imaging system [6], we obtained images of old rat's brain and testicular tumors. The X-ray energy was set at 35keV. Experiment was performed at the vertical wiggler beam line 14C of the Photon Factory, Tsukuba, Japan. Two and three-dimensional images were reconstructed using 3D volume-rending software (Real INTAGE; KGT Inc., Japan).

After phase-contrast X-ray CT examination, all specimens were sliced into 3-μm-thick sections and stained with Hematoxylin and Eosin (HE). All images were compared with corresponding pathological pictures.

The experimental protocol was approved by the President of Kitasato University through the judgment of the Animal Care and Use Committee of Kitasato University.

3 Results and Discussion

Phase-contrast X-ray CT without contrast agent, enabled to clearly demonstrate pathological and anatomical structures of rat's brain such as tumor located in the brain stem, cortex, caudate putamen, hippocampus, and corpus callosum [7]. Phase-contrast X-ray CT also revealed the rat' testes including seminiferous tubules, tunica albuginea, blood vessels and interstitial tumors (Fig1. A). Both tumors were well differentiated from the surrounding normal tissue. Various pathological features of tumor, e.g., its cell density and microvasculature, and blood clots caused by hemorrhaging and/or hematomas, were clearly observed in three-dimensional images. Phase-contrast X-ray CT images resembled pathological pictures with a magnification of ×20 in two dimensional image. In addition, tumor vascularity up to approximately 26 μm in diameter were clearly visible in three dimensional images (Fig.1 B).

Phase-contrast X-ray CT enabled to depict the tumor morphology, especially micro-vasculatures on spontaneous tumor of small animals.

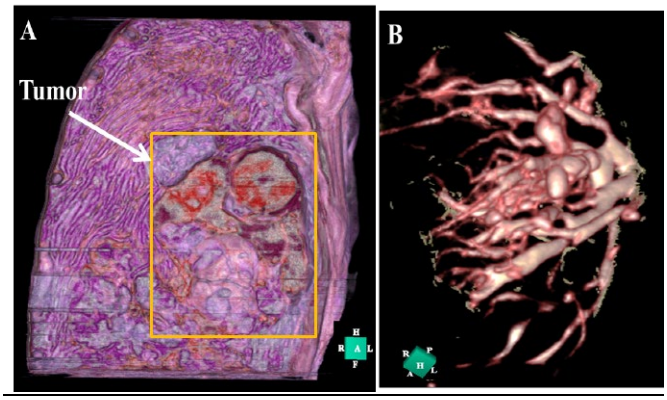

Fig. 1: Phase Contrast X-ray CT image.
Three-dimensional reconstruction image of testes with tumor (A), Three-dimensional reconstruction image of tumor microvasculature (B).

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