Approach to Determine the Distribution of a Contrast Agent in the Brain by MRI and X-ray Synchrotron Radiation Computed Tomography (SRCT)

G. Le Duc
Jeune Equipe RSRM (Université J. Fourier), Medical Beamline, ESRF, Grenoble, France

A. M. Charvet, H. Elleaume, and F. Estève
Jeune Equipe RSRM (Université J. Fourier), Grenoble, France

S. Fiedler, T. Brochard, C. Nemoz, and M. Rénier
Medical Beamline, ESRF, Grenoble, France

C. Foucou
Jeune Equipe RSRM (Université J. Fourier), Grenoble, France

P. Suortti and P. Spanne
Medical Beamline, ESRF, Grenoble, France

A. Collomb and J. F. Le Bas
Jeune Equipe RSRM (Université J. Fourier), Grenoble, France

A computed tomography system for clinical studies in brain pathology is one of the projects of the medical beamline at the ESRF. Our aim is to answer the following question: Is it possible to obtain brain CT images selectively and quantitatively to be representative for the absolute concentration of contrast agents (like gadolinium and iodine) at clinical doses by performing K-edge subtraction measurements with a synchrotron x-ray source? Preliminary experiments on phantoms showed that 1mg/cm^3 (±10%) of iodine or gadolinium is quantifiable in a 6-mm diameter detail and 2 mg/cm^3 (±10%) in a 3-mm diameter detail with geometry and dosimetry parameters close to conventional CT (surface dose <5 cGy). Our goal is now to perform preclinical studies with several animal models.[1,2] An anesthetized rat bearing a glioma was studied both by MRI and SRCT and then was sacrificed for histology. MRI scans were carried out before and after gadolinium injection. SRCT was performed by using the K-edge subtraction technique after iodine injection at the medical beamline of the ESRF. We clearly observed a contrast enhancement in the subtracted images. The measured concentration of the iodine in the SRCT image was equal to 0.6 mg/cm^3. This concentration was checked by measurements on several tubes filled with known concentrations and taped on the rat set-up. The localization and the shape of the tumor determined by the contrast enhancement observed on the SRCT images was found to be in good agreement with the MRI scans and histological stainings. To our knowledge, this imaging method had never been carried out on an anesthetized animal. Starting from these results, we will optimize the protocol and try to provide quantitative mapping of iodine and also gadolinium contrast agents in animal models (pathological brains, excised perfused livers and hearts). Such preclinical studies could be interesting to obtain quantitative information relative about the distribution of contrast agents in MRI and/or x-ray examinations.

———

[1]Dilmanian, F. A., Garrett, R. F., Thomlinson, W. C. (1991) Nuc. Instrum. Methods; B56-57: 1208-1213.
[2]Elleaume, H., Charvet, A. M., and Le Bas, J. F. (1997) Acta Radiologica; 412: 29-41.