Contribution ID: **124** Type: **poster**

Dual SPECT/MR imaging in small animal

Thursday, 11 May 2006 14:00 (20 minutes)

Small animal imaging techniques provides the possibility to follow non invasively and in vivo the morphological or functional evolution of a particular organ or tissue over time. The aim of dual imaging is to combine morphological and functional information. Among multimodality imaging techniques for co-registration of mutual information, SPECT/MRI has not, to our knowledge, be applied practically due to complex interactions between magnetic field and nuclear instrumentation. We describe and illustrate our practical experience in small animal sequential SPECT/MR images acquisition and fusion. For SPECT imaging we used a small animal dedicated rotating single head gamma camera with a 1.5mm diameter tungsten pinhole collimator and 12cm in focal distance (Gaede, Freiburg, Germany) and an algebraic reconstruction method able to achieve isotropic millimeter 1x1x1mm3 spatial resolution [1, 2]. MRI was performed on a low field 0.1T open system (Bouhnik SAS, Vélizy-Villacoublay, France) with an homogeneous (10-6) imaging volume of 10x10x6cm3 [3]. 3D MR sequences are developed on a SMIS (Guilford, UK) console to achieve isotropic resolution of 0.4x0.4x0.4mm3, or high in plane resolution of 0.25x0.25mm² and 1mm slice thickness, in less than 2h acquisition times. As sizes of our dual imaging devices (SPECT 103x80x140cm, low field MRI 72x40x118cm) fits in a single room and as the 5 Gauss line is located at a few centimeters from the magnet, pinhole SPECT camera and anesthesia set were located directly next to the MR magnet, without interfering.
Small animal (mouse or rat) is maintained under gaseous anesthesia (isoflurane 0.5-1.5%, 0.3L.min-1) in a warmed-up and non-magnetic technical cell dedicated to small animal imaging (CTI, Minerve, Esternay, France) and adapted for both SPECT and MRI devices. This imaging chamber isolates the animal during its transport and imaging thanks to a bite bar warranting the animal positioning from one imaging experiment to the other. After sequential SPECT and MRI acquisitions, co-registration of images is obtained with the AMIDE [4] software (UCLA, California) helped by location phantoms placed on the cell bed. Advantage of the cell concerns transport of the anesthetized animal from one imager to another minimizing therefore the delay between acquisitions without requiring any more manipulation. During the dual imaging experiments in mice, we were able to keep the animals under anesthesia inside the cell up to 10h without consequences.
As a proof of experience of this dual imaging modality, we performed sequential SPECT/MRI of implanted glioma brain tumors in adult swiss nude mice (Transgene S.A., Strasbourg, France). Intra-peritoneal administration of 1mL of 0.5mmol of Gadolinium (Dotarem, Guerbet, France) was followed by IV injection of 0.2mL of 700MBq of 99mTc-Sestamibi (BMS, Rueil-Malmaison, France) before dual imaging. For SPECT, 48 projections of 1min in a 64x64 format and 4.5cm radius of rotation was used. For MRI, 3D T1 and T2 weighted images were acquired, with the high in plane resolution specified previously, in less than 4h. Co-registration of brain SPECT/MR images was then applied after dual modality image reconstruction allowing for differentiation of brain edema and tumor metabolism.

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Session Classification: Poster session : Imaging systems, Molecular Imaging

Track Classification: • Biomedical perspectives and technical challenges for morpho-functional imaging (multimodality : PET/CT,SPECT/CT,PET/MRI,SPECT/MRI ...)