A new SPECT/CT device with sub-half-mm resolution SPECT for imaging of Molecules and Organs in Action

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Aims

Pivotal questions in pharmacology and biology concern how function of localized cells relates to disease. For example in experimental neuroscience we have dreamt about a magnifying glass that would allow us to see neurotransmitters in action, in cardiovascular research about a system that would provide us simultaneously with myocardial anatomy, mechanical function and cell function, and in cancer research to see detailed dynamic distributions of pharmaceuticals and markers, in small animals serving as models for human disease. Such studies have been limited by the availability of methods to study such molecular dynamics. A Single Photon Emission Computed Tomography system called U-SPECT has been developed.[1-5] It can quantify tracer dynamics in <0.35mm structures e.g. in murine brain, heart and tumors and was recently integrated with a fast CT (1178 Skyscan). This combination is essential for anatomical localization of SPECT tracers.

Method

U-SPECT uses sophisticated focusing pinhole geometries together with unique 3D focusing technology and list mode data acquisition. Novel reconstruction methods that enable to enhance resolution are applied, accelerated by pixel-based block iterative update schemes. The integrated SkyScan 1178 CT is high-throughput micro-CT and offers a scanning and reconstruction cycle of less than one minute for the entire volume.

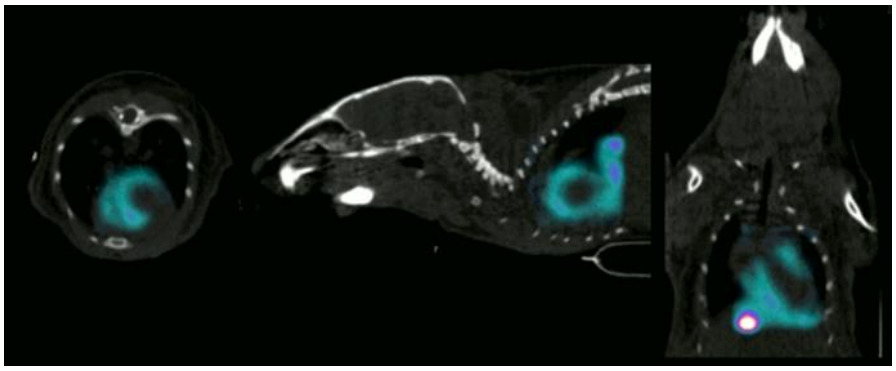

Figure 1: Fused U-SPECT and CT scan of a mouse heart showing myocardial infarction. Courtesy of Dr. Fatih Arslan, Laboratory of Experimental Cardiology University Medical Center Utrecht, The Netherlands

Results

Examples include imaging the density and occupancy of dopamine transporters in sub-compartments of the brain, sub-half-mm resolution dynamic myocardial perfusion imaging or imaging of tumor markers and anti-cancer agents (e.g. antibodies) in micro-metastasis, all during a range of points in time (see Figure 1-4). Applied to different models of disease this will aid our understanding of dynamic processes that underlie tissue functions and human pathology. New sub-half-mm resolution U-SPECT-II and U-SPECT/CT images and movies with sub-minute resolution will be shown.

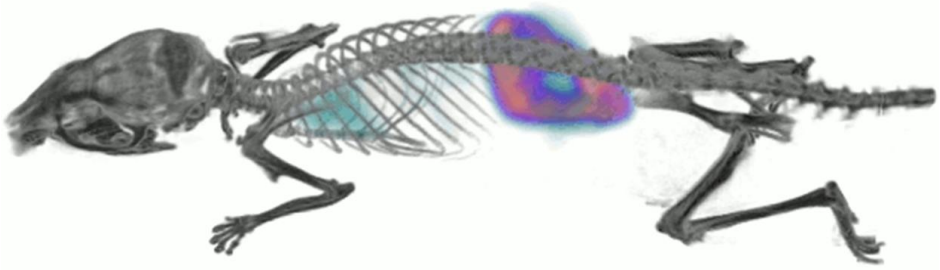

Figure 2: Fused U-SPECT/CT female SCID mouse with a subcutaneous tumor xenograft. 39 MBq 111In labeled human antibody injected against a tumor antigen 45 min total body scan 48 hrs post injection. Courtesy of Dr. Wim Bleeker, Genmab B.V. Utrecht, The Netherlands

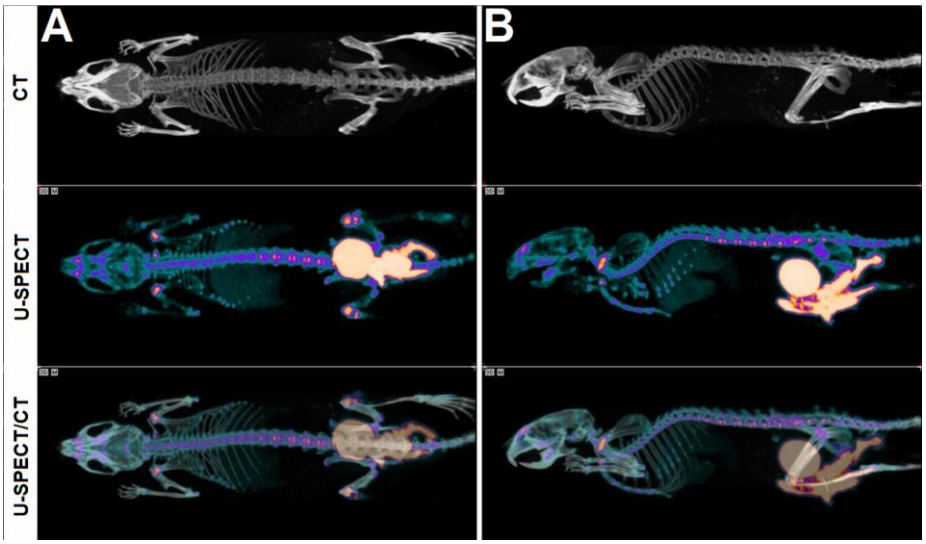

Figure 3: Maximum intensity projection images of registered total-body mouse scans. Top row: CT image, middle row: SPECT bone image and bottom row: fused SPECT-CT image. The mouse was injected with 725 MBq of [99mTc] hydroxy methylene diphosphonate (HDP) ([99mTc] HDP) and was anesthetized using isoflurane during scanning.

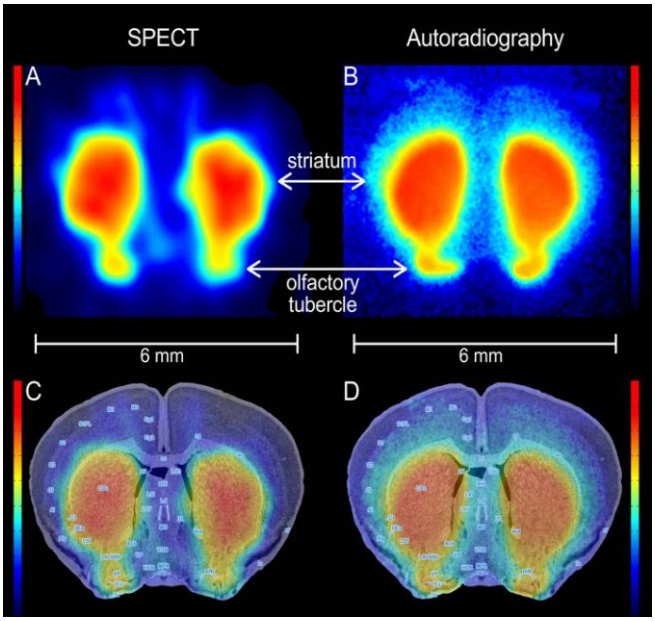

Figure 4: Mouse brain showing sub-compartments perfectly matching anatomical map[3]

Conclusion

An overview of the U-SPECT-II/CT technology will be given as well as current research at Delft University of Technology and MILabs.

References:

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