Quantification using 2D scintigraphic versus 3D SPECT imaging in pre-clinical oncology studies: A Comparative Analysis.

Maritina Rouchota[1], Irineos Pilatis[2], Panagiotis Tsialios[3], Maria Georgiou[3], Eleftherios Fysikopoulos[3], Sophia Sarpaki[3], George Loudos[3], George Kagadis[1]

1 University of Patras, Department of Physics, Patra, Greece
2 University of West Attica, Agaleo, Greece
3 Bioemission Technology Solutions (BIOEMTECH), Lefkippos Attica Technology Park, NCSR "Demokritos", Ag. Paraskevi-Athens, Greece

Aim

Preclinical studies hold the most prominent tool in oncology research. The gold standard in any oncology experiment is still ex vivo biodistributions, an invasive method that requires a large number of animals. Studies have shown that both planar (2D) and tomographic (3D) imaging provide high correlation to ex vivo studies and can be trusted as an alternative to bio kinetics [1]. Usually tumors are subcutaneous thus do not overlap with other organs. In this study, a set of oncology imaging studies, performed both on 2D and 3D systems and are compared against biodistribution data, to evaluate the correlation between the methods.

Materials & Methods

We have analysed 6 oncology experiments, with more than 30 mice and 3 different isotopes, in 2D and 3D SPECT and ex vivo bio-distributions. Real-time, dynamic screening was performed on γ-eye™ (BIOEMTECH, Greece), and quantification on its embedded analysis software, visual|eyes™. Tomographic SPECT/CT imaging was performed on X-CUBE/γ-CUBE (Molecubles, Belgium) and post-processing on VivoQuant (Invicro, Boston). ROIs or VOIs respectively, are drawn on major organs and the counts are translated to %ID/organ. For the biodistributions studies, organs were measured in a gamma counter and results calculated as %ID/organ. Before the in vivo experiments, acquisitions were also performed on BIOEMTECH's fillable mouse phantom for preclinical studies (BIOEMTECH, Greece), depicting real-size mouse organs as well as two tumours.
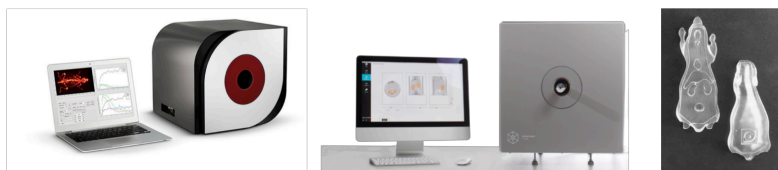

Figure.1: From left to right: Imaging systems: γ-eye™ by BIOEMTECH & γ-CUBE™ and X-CUBE™ by Molecules, the fillable mouse phantom by BIOEMTECH.

References: [1]. Dan Yang et al. Exogenous Gene Expression in Tumors: Noninvasive Quantification with Functional and Anatomic Imaging in a Mouse Model. Radiology, 235, 3 (2005).

Results

The difference in uptake values between 2D and 3D imaging was measured for a set of 30 mice, in 3 different projects and was calculated as (4.9 ± 3.2)%. For the 5 mice that also went through an ex vivo evaluation, the correlation between imaging and ex vivo biodistribution values differs on average by (8.1 ± 2.6)% for 2D and 3D. An example of the imaging data can be seen in Figure 2.

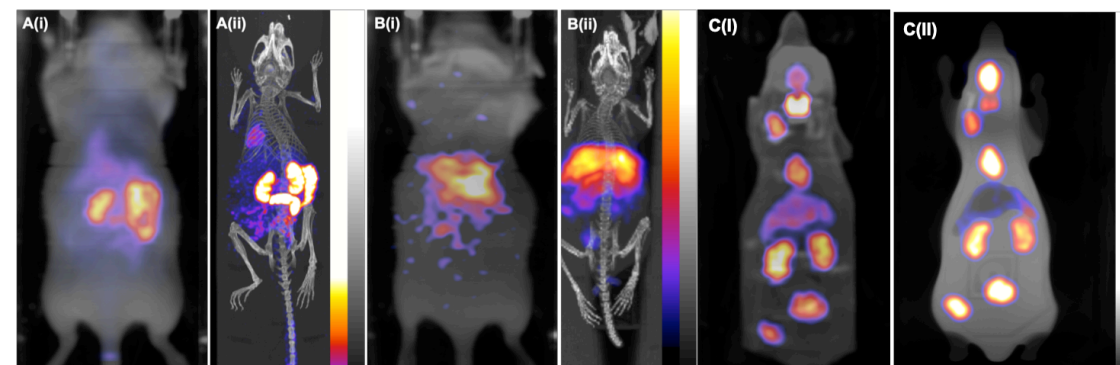Figure 2: A(i) 2D image (γ-eye™) of an experimental breast oncology mouse model, injected with 1 mCi of Tc99m-Sestamibi and A(ii) the corresponding tomographic image (CUBES™) B(i) 2D image (γ-eye™) of a lung cancer model injected with 30 uCi of an In-111 labelled compound B(II) The corresponding tomographic image (CUBES™). C (i) 2D image (γ-eye™) of BIOEMTECH's fillable mouse phantom, filled with 500 uCi of In-111 and C (ii) corresponding tomographic image (CUBES™).

Conclusions

Both imaging techniques present a very similar trend in comparison to ex vivo biodistributions. However, 2D imaging offers a number of additional advantages, such as speed, simplicity, real time imaging, and ability to provide very short time frames and extraction of time activity curves by the end of the experiment. This study demonstrates that for applications were organs are well separated, 2D scintigraphy provides similar results to 3D SPECT. In addition, it allows the reproduction of time activity curves with the same accuracy as ex vivo biodistribtuions, while significantly reducing in the number of animals required and increasing overall statistical accuracy.