

Five Energy Window Scatter Correction for ^{111}In μSPECT

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I. INTRODUCTION

In preclinical molecular imaging, large interest exists for absolute quantification of μSPECT (Single Photon Emission Computed Tomography) images. To date, μSPECT images are only qualitative or semi-quantitative. Although these images permit the comparison of different regions in the brain or the uptake estimation in a tumor, great progress in preclinical research is expected from absolute quantification, since this would allow an accurate evaluation of disease progression and therapy or drug effectiveness in the same small animal. Indium-111 (^{111}In) can be used for in vivo evaluation of tumor selectivity, and hence the potential therapeutic performance of a tracer. The monoclonal antibody 14C5 for example, labeled to ^{111}In -DOTA or ^{111}In -DTPA, has shown to be a promising new antibody for targeting pancreatic cancer cells. As mentioned by Hwang et al [1], photon scatter is one of the limiting factors for quantitative imaging. The aim of this study was to investigate a scatter correction method using five energy windows (FEW) for ^{111}In μSPECT imaging.

II. MATERIALS AND METHODS

A. FEW scatter correction method

Our scatter correction method requires 5 energy windows (EW): a 20% main EW around each photopeak, an 8% scatter EW at both sides of the 171keV photopeak and an 8% scatter EW

at the left-hand side of the 245keV photopeak. In Fig.1 the EWs and the estimated amount of scatter present in the photopeaks are shown.

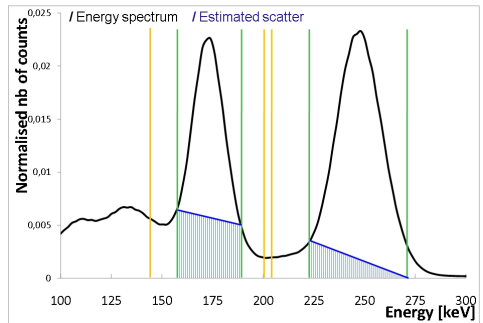


Figure 1. FEW scatter correction method.

B. Simulation study

As the contribution of scatter in small animals is known to stay limited for ^{111}In , one could wonder whether it is useful to apply scatter correction in preclinical studies. However, next to phantom scatter, collimator scatter and backscatter also have to be considered. To quantify the total scatter contribution present in both photopeaks, a Monte Carlo simulation of a digital mouse phantom (MOBY) [2] was performed. The simulation was carried out using GATE [3] (Geant4 Application for Tomographic Emission). A realistic mouse study, where MOBY was stepwise moved through the U-SPECT II (Milabs) [4] system, was imitated.

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C. Experimental measurements

To evaluate the FEW scatter correction technique, a preclinical study was performed. Three tumor-bearing mice were injected with ^{111}In -DTPA-14C5 or ^{111}In -DOTA-14C5. They were scanned with the U-SPECT II system between 48 and 72 hours after antibody injection, since tumor uptake has shown to be the highest in this time range. After acquisitions, image reconstruction was performed with the scanner software (OSEM algorithm with 16 subsets and 3 iterations) to create an uncorrected and a FEW corrected image of each mouse. A tumor-to-background ratio (mean pixel value in the tumor divided by the mean pixel value in a background ratio) was then computed for all reconstructed images.

III. RESULTS

A. Simulation study

The ^{111}In energy spectrum obtained for the MOBY simulation is shown in Fig.2: the total amount of detected photons and the complete scatter contribution are shown. We could deduce that the number of scattered photons equal 32.6% and 12.1% of the total amount of detected photons in respectively the first and second photopeak. Taking a closer look at the different scatter types demonstrated that the contribution of phantom scatter stays limited to only 8% and 3% of the total number of counts in the photopeaks. So, it are collimator scatter and backscatter which account for the most important part of scatter contamination.

B. Preclinical mouse study

The tumor-to-background ratios obtained for the three mice are 4.0 (DTPA), 4.9 (DTPA) and 5.2 (DOTA) without any correction, while the corresponding values after FEW scatter correction equal 4.7, 6.0 and 6.9. This means that our scatter correction technique gives rise to an average improvement of 24%.

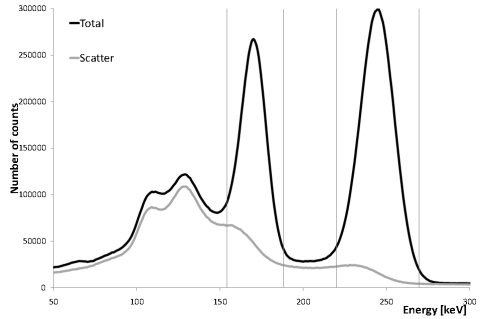


Figure 2. The ^{111}In energy spectrum.

IV. CONCLUSION

This study presented a FEW scatter correction technique for ^{111}In images. As we showed that scatter contamination, especially collimator scatter and backscatter, accounts for a significant contribution in both photopeaks, our scatter correction method may offer an important improvement in the absolute quantification of ^{111}In μSPECT images for realistic preclinical studies.

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