Effect of Data-Driven Respiratory Gating on Radioactivity Quantification in Liver Lesions for Pre-Radioembolization Tc-99m-MAA SPECT/CT

James C. Sanders[1,3], A. Hans Vija[2], Torsten Kuwert[3], Philipp Ritt[3]

[1]*Pattern Recognition Lab, University of Erlangen-Nuremberg*
[2]*Siemens Molecular Imaging*
[3]*Clinic of Nuclear Medicine, University Hospital Erlangen*

Aims:

In single photon emission-computed tomography (SPECT), comparatively long acquisition times may lead to blurring and underestimation of radioactivity in foci moved by respiration. This can be mitigated by respiratory gating, whereby a surrogate signal representing the patient's respiratory state is used to subdivide the data into gates, within which motion is assumed negligible. Individual gates can then be analyzed separately.

The aim of this study was to examine the extent to which radioactivity in liver lesions varies after respiratory gating is applied.

Methods:

After granting informed consent to participate in the study, 7 patients (5M/2F) aged 64.9±5.8 Y were injected intraarterially with 143.7±43.5 MBq Tc-99m-MAA (microaggregated albulin) as part of our clinic's standard Y-90 radioembolization planning protocol. A SPECT/CT acquisition was then performed using a Symbia T2 (Siemens Molecular Imaging) with 60 views (15 sec each). List-mode data was acquired, and, using a fully-automated, data-driven gating method, a respiratory-gated dataset with 5 gates was generated in addition to the standard ungated dataset. Reconstruction was carried out with a research version of xSPECT Quant (20 iterations/1 subset). CT attenuation and scatter correction, but no post-smoothing, was performed.

Magnetic resonance (MR) images were selected for each patient and co-registered with SPECT reconstructions. Using the MRs, volumes of interest (VOIs) were defined for each patient around lesions exhibiting tracer uptake. Within each VOI, the ratio R of activity in each gated reconstruction to that in the ungated reconstruction was then computed.

Results:

For 13 of the 16 VOIs assessed, R>1 for at least one gate, indicating underestimation of activity in the ungated reconstruction. Taking the maximum R for each lesion, the mean across all VOIs was 1.15±0.22. Taking the minimum, the mean was 0.82±0.10. For each lesion, the average deviation across all gates was 0.09±0.09.

Conclusion:

In this study, 81.3% of examined lesions showed underestimation in the ungated dataset, the average magnitude of which was 15%. This implies that blurring due to respiratory motion incurs a bias on ungated SPECT images. Variation across gates for each lesion was due to activity passing in and out of the static VOI as the patients breathed. Although not affecting the lung/liver shunt currently used for radioembolization planning, underestimation of tumor activity may have implications on future efforts to personalize therapy to maximize tumor dose.

One limitation of the study is the small number of patients analyzed, which must be increased to reach a definite conclusion.