

## **Respiratory Corrected PET Image Using 4D-CT Deformable Registration; a Phantom Study**

Byung-Chul Cho<sup>1</sup> Hee-Soon Shin<sup>3</sup>, Hee Sung Hwang<sup>2</sup>, Su-Ssan Kim<sup>1</sup>, Sang-Gyu Choi<sup>1</sup>, and Hoonsik Bae<sup>1</sup>

<sup>1</sup> Department of Radiation Oncology, Hallym University College of Medicine, <sup>2</sup> Division of Nuclear Medicine, Department of Radiology, Hallym University College of Medicine,

<sup>3</sup> GE Healthcare, Korea

[bychul@hallym.or.kr](mailto:bychul@hallym.or.kr)

To reduce those breathing induced motion artifacts in PET imaging, methodologies of respiratory-gated PET (RGPET) and respiratory correlated dynamic PET (RCDPET) were proposed recently. Although those techniques have been proven to reduce respiratory motion artifacts effectively, the problem of relatively long acquisition time has yet to be overcome. The purpose of this study is to demonstrate that the respiratory corrected PET image registration using the information of the deformable registration on the corresponding 4DCT data can be used to solve the time limit of RGPET. To simulate respiratory organ motion, a motion phantom was made to move periodically. The phantom of 19.5 MBq/ml <sup>18</sup>F-FDG activity in a cubic shaped background has three hot regions with different size and activity of 9.7 MBq/ml. Five PET studies and one 4DCT study were performed with the motion phantom; 1) 3-min non-gating PET with spiral CT, 2) 1-, 5-, and 10-min RGPET, 3) 10-minute static PET and CT, and 4) 4DCT. For registration of 4DCT datasets, we used the deformable registration technique in the Insight Toolkit, where an implementation of Thirion's demons algorithm for deformable registration of intra-modality images is provided. The CT image of the 0% phase was selected as a reference data and every other CT image was registered to the reference image. At the final stage of the registration, the displacement field of each phase was then saved for warping every other RGPET image into the 0% phase one. The Overlap Index as the evaluation of registration of PET/CT data was analyzed. To evaluate noise level of non-gating, gating, static with no motion and deformed data, Signal to noise ratio (SNR) and Contrast to noise ratio (CNR) were also analyzed. As results, averaged 1-min RGPET image after deformable registration shows 2-3 times better image quality compatible to the 10-min static PET scan.

**Keywords :** Respiratory Gated PET, 4D-CT, Deformable Registration