Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

Is Necessary Attenuation Correction for Cat Brain PET?

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1. Introduction

Photon attenuation and scatter corrections (AC and SC) were necessary for quantification of human PET. However, there is no consensus on whether AC and SC are necessary for the cat brain PET imaging.

Since post-injection transmission (TX) PET scans are not permitted or provided to microPET scanner users at present, additional time for performing TX scan and awaiting FDG uptake is required for attenuation and scatter corrections. Increasing probability of subject movement and possible biological effect of long term anesthesia would be the problem in additional TX scan.

The aim of this study was to examine the effect of AC and SC for the quantification of cat brain PET data.

2. Methods and Results

We have developed and validated 3D voxel based statistical analysis for cat brain PET data in previous study [1]. In this study, we studied whether AC and SC were necessary for quantification at the cost of additional PET scan.

2.1 FDG PET Data Acquisitions

Nine cats (mean weight: 2.66 ± 0.63 kg) were used in the experiment. Before PET scanning, cats were fasted for at least 8 hours. The cats were anesthetized initially with an intramuscular injection of ketamine and xylazine mixture (100 mg/kg and 10 mg/kg, respectively), and subsequently ketamine was injected intravenously every 30 minutes to maintain anesthesia. After achieving anesthesia, transmission (TX) scan using ^{68}Ge source was performed for 30 min before the tracer (1 mCi/kg) injection. TX scan was performed using singles mode. After 30 min uptake time of FDG, emission (EM) scan was performed for 30 min with an energy window of 350~650 keV. PET data was acquired in list mode, and list mode data was histogrammed into 3D sinograms with a span number of 3 and a ring difference of 47. These 3D sinograms were then reconstructed using Maximum *a posteriori* (MAP) algorithm (matrix size = 128 x 128 x 95). Image pixel sizes were of 0.865 mm transaxially and of slice thickness 0.796 mm. AC and SC were performed for all data set..

2.2 Extraction and spatial normalization of Cat brain

Cat brain has larger soft tissue and other non brain regions. So, spatial normalization could not perform properly. Therefore, only brain region should be extracted for the efficient spatial normalization [1]. For the spatial normalization, a PET image with good quality was selected as a temporary target template from the normal cat data set. Only brain regions were extracted from each data set by manual masking and thresholding. All brain images were then spatially normalized onto the temporal target brain. Cat brain template was then composed of mean image of 9 spatial normalized PET data. Each PET data were then spatially normalized onto cat brain template and smoothed with a Gaussian kernel using SPM (Statistical Parametric Mapping; Institute of Neurology, University College of London, UK) software [2].

2.3 Voxel-wise Statistical Analysis

Voxel-wise statistical analysis was performed to identify brain areas showing cerebral glucose metabolism differences between uncorrected cat brain PET data and Attenuation & Scatter corrected (AC&SC) cat brain PET data. The pixel values of the smoothed PET images were normalized with respect to the global mean of the image intensity (count normalization by the proportional scaling in SPM), to remove the effects of different injection doses and individual differences in the global uptake. Voxel-wise paired *t*-test using SPM was performed to identify the difference between uncorrected cat brain PET and AC&SC cat brain PET data.

2.4 Increased metabolic area of AC&SC over uncorrected PET data

Increased metabolic areas of AC&SC PET data over uncorrected PET data were not found in all regions of cat brain (Figure 1) *($p > 0.01$).*

2.5 Decreased metabolic area of AC&SC over uncorrected PET data

No decreased metabolic areas of AC&SC PET data over uncorrected PET data were also found in the cerebral cortex (Figure 2) *($p>0.001$, $k=200$).* Decreased metabolic areas were detected just in white matter and ventricles.

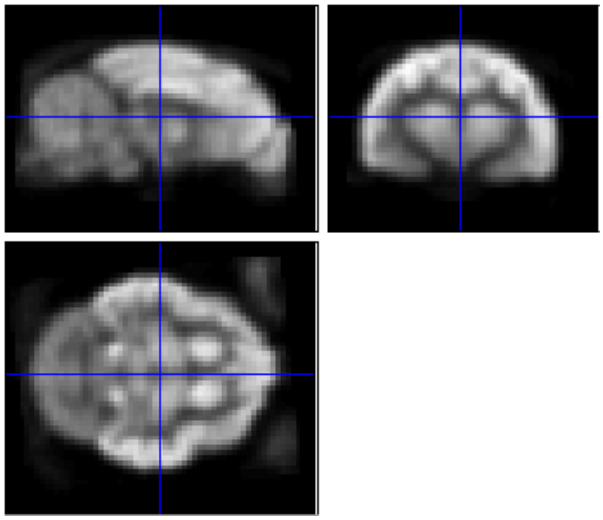

Figure 1. Increased metabolic area of AC&SC PET data over uncorrected PET data ($p > 0.01$)

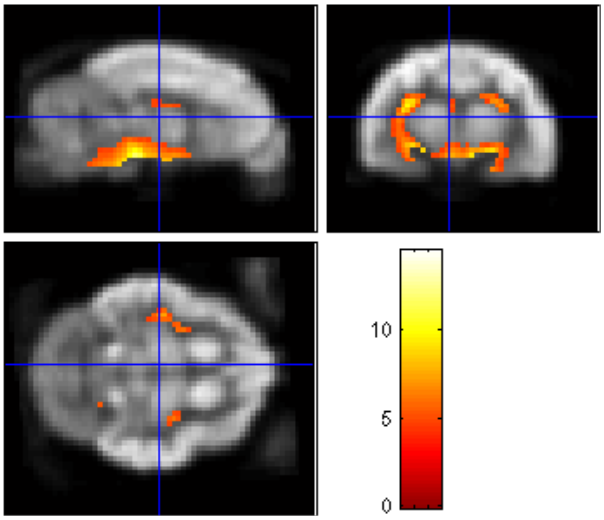

Figure 2. Decreased metabolic area of AC&SC PET data over uncorrected PET data ($p > 0.001$, k=200)

3. Conclusion

In this study, the effects of AC and SC were examined in the cat brain FDG PET using microPET Focus 120 scanner. After AC and SC, cerebral glucose metabolism was not decreased or increased in whole cat brain area including deep gray matter and cerebral cortex. These results demonstrate that attenuation and scatter correction are not necessary for quantification of cat brain PET.

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