Feasibility of 18F-FDG Radio-Tracer Dose Reduction in Simultaneous Carotid PET/MR Imaging

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TARGET AUDIENCE: Researchers and clinicians interested in vascular PET-MRI.

PURPOSE: 18-F-Fluorodeoxyglucose (18-F-FDG) Positron emission tomography with computed tomography (PET/CT) has been used to evaluate vascular inflammation. A major advantage of simultaneous PET/MRI systems is that they deliver less ionizing radiation compared to that from PET/CT. Moreover, because MR exams are generally longer in duration than CT, further reduction in radiation exposure could be achieved by administering lower doses of the radioactive tracer used in PET imaging and matching the duration of the PET acquisition to that of the MR exam. This strategy could result in high quality PET data, even when a lower dose of radio-tracer is injected. The purpose of this study was to evaluate the feasibility of dose reduction of 18F-FDG for quantifying carotid plaque inflammation clinically using a simultaneous PET/MRI scanner.

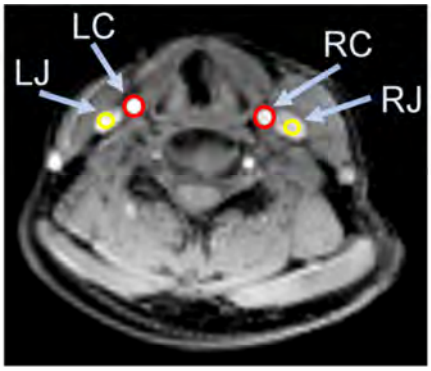

Figure 1: Regions of interest on MR imaging used for PET TBR calculations. LC: Left Carotid; RC: Right carotid; LJ: Left Jugular; RJ: Right Jugular.

METHODS: This study was approved by the local institutional review board. All participating subjects signed written informed consent. Five subjects (mean weight = 77.1 ± 15 kg; mean age = 32.2 ± 13 years) were recruited for this study. All subjects underwent two scans in a randomized order using the clinical dose of 18F-FDG (378 ± 68 MBq) for 8 minutes and a low dose (68 ± 18 MBq) for 75 minutes on the Siemens Biograph mMR (Erlangen, Germany). Low dose PET scans were reconstructed using the first 8, 24, 45, and 75 minutes of the data to be compared to the full duration of the standard dose scan. All reconstructions were performed using the scanner standard iterative reconstruction (PSF-OP-OSEM using 3 iterations and 21 subsets, 4 mm Gaussian post-reconstruction smoothing; 2.09x2.09x2.03 mm^3). Quantitative comparisons were performed using the target to background ratio (TBR) metric within regions of interest (ROIs) that was drawn manually on corresponding volumetric MR images (TR=1000 ms; TE=4.89 ms; 1.67 mm isotropic resolution) that were co-acquired within the same imaging session (**Figure 1)**. The evaluated ROIs were the left carotid (LC), right carotid (RC) and were normalized by the left jugular (LJ) and right jugular (RJ) respectively. Statistical analysis to compare quantification of standard dose and low dose 18-F FDG PET was conducted using a one-way ANOVA with Bonferroni post hoc correction. $p<0.05$ was considered statistically significant.

Table 1: Target to Background ratios obtained from PET

Vessel	Standard Dose (8 minutes)	Low Dose (8 minutes)	Low Dose (24 minutes)	Low Dose (45 minutes)	Low Dose (75 minutes)
Left Carotid	1.27±0.26	**1.14±0.17***	1.22±0.13	1.24±0.13	1.28±0.13
Right Carotid	1.24±0.19	1.25±0.20	1.28±0.15	1.27±0.14	1.28±0.13

*Bold indicates significant differences; Mean ± Standard Deviation presented

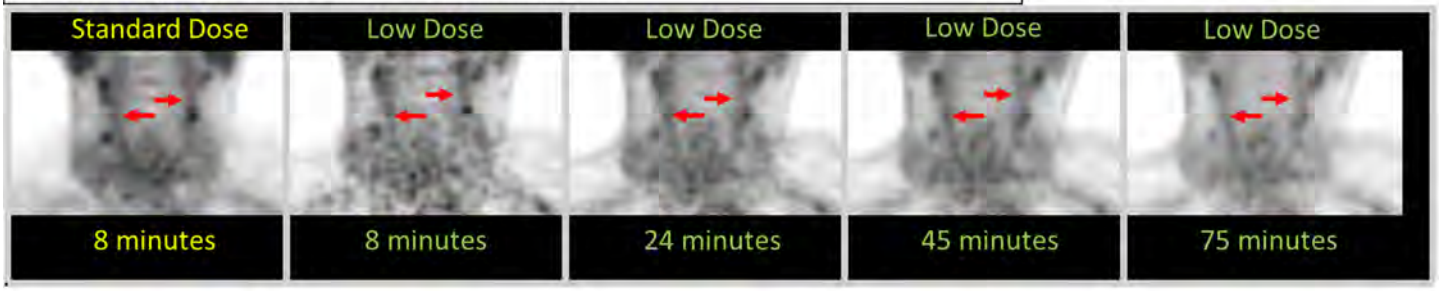

Figure 2: Representative coronal PET images in the same subject using the clinical standard dose of 18F-FDG acquired for 8 minutes compared to low dose images acquired for 8, 25, 45 and 75 minutes. Red arrows indicate the carotids.

RESULTS: A sample standard dose PET image compared to the low dose PET images is shown in **Figure 2** for qualitative evaluation. Increased FDG uptake can be seen in the LC and RC as highlighted by the arrows indicating inflamed plaque. On the other hand, low dose images are noisier at short durations, but image quality improves with longer durations as more counts are used in the reconstruction making the inflamed vessel more discernible. Quantitative results are summarized in **Table 1**. In summary, no significant differences in TBR were measured for both the RC and LC expect for the 8-minute low dose images in the RC.

CONCLUSIONS: Lowering the 18F FDG dose and extending the duration of the PET acquisition can achieve excellent image quality. More importantly, similar PET quantitative metrics can also be achieved with the low dose scan compared the current clinical standard. Taken together, the advent of the simultaneous PET/MRI could significantly lower the radiation exposure to the patient making it a more desirable tool for repeated scans for disease evaluation and for monitoring therapeutic interventions compared to PET/CT.