FDG-PET imaging with first combined Whole-Body MR-PET vs. conventional PET/CT: qualitative and quantitative comparison of results

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Introduction. There are many motivations for combining PET and MR scanners together. The most straightforward are the excellent soft tissue contrast, the elimination of the extra radiation from the CT (used to provide both anatomical and attenuation-correction information) and the multifunctional imaging ability (thanks to a wide spectrum of MR sequences and techniques) that complements the functional molecular information from the PET [1]. The impact of replacing the CT by an MR scanner affects the PET performance by two main factors. The first one is the impact of the strength of the magnetic field on the performance of the PET detectors (photo-multipliers tubes, PMTs) [2]. And the second one, by replacing the attenuation correction map from the gold-standard (CT map) by an approximation derived from an MR image [3].

The first combined Whole-Body MR-PET system in the world (Philips) was installed at the Translational and Molecular Imaging Institute (TMII) at Mount Sinai Hospital (New York, NY). This system provides sequential MRI and PET acquisition by combining standalone PET and MR scanners face to face, together with an innovative rotating bed that accurately positions the patient inside each scanner (see Fig. 1).

The objective of this study is to evaluate the performance of the combined Whole-Body MR-PET scanner in terms of its quality and a quantitative analysis compared to a conventional clinical PET/CT scanner.

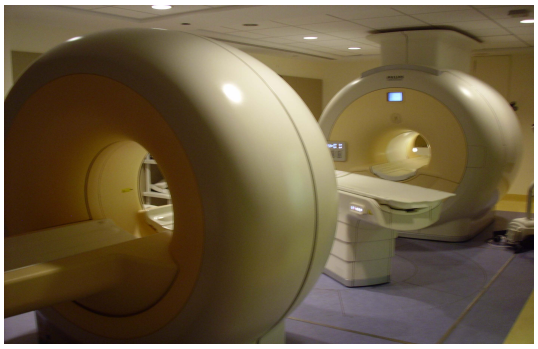

Figure 1: Image of the first combined Whole-Body MR-PET scanner at Mount Sinai Hospital, New York.

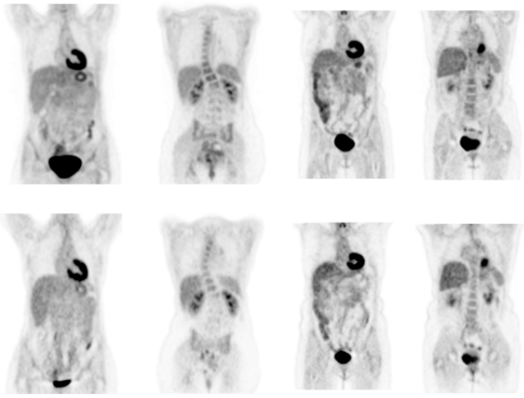

Figure 2: Whole-Body PET images from the MR-PET scanner (top row) and the coregistered PET images from a clinical PETCT (bottom row).

Methods. 15 patients were scanned on the new combined Whole-Body MR-PET scanner (Philips) immediately following a clinical PET/CT scanner (GE DLS system). Regions of interest (ROIs) were placed on the coregistered PET data from the PET/CT and MR-PET images on 5 different types of tissue-organs: lungs, aorta, heart, liver and fat/soft tissue. Three ROIs were drawn at each organ of interest. Mean and maximum standardized uptake values (SUV) were reported from both coregistered PET images (PET/CT and MR-PET).

Pearson's correlation, intra-class correlation and independent samples t-test were performed using SPSS software. All patients gave written informed consent and the study was approved by the Institutional Review Board of the Mount Sinai School of Medicine.

Results. The mean imaging time post injection was (mean ± SD): 73 ± 18 min for PET/CT and 168 ± 35 min for MR-PET imaging. Fig. 2 shows comparative images of the same patient on a standard clinical PET/CT scanner (bottom row) and on the combined Whole-Body MR-PET scanner (top row). Fig. 3 shows an example of the correlation of SUV mean values between the PET/CT and the MR-PET images. Pearson's correlation values of SUV mean and SUV max value are 0.91 and 0.97 ($p<0.0001$) respectively. Intra-class correlation values (95% C.I.) for SUV mean and SUV max are 0.9 (0.84 – 0.93) and 0.89 (0.84 – 0.93) respectively.

Discussion: The data presented in this study summarize the feasibility of FDG-PET with the new combined Whole-Body MR-PET scanner. Excellent correlation values were obtained for both SUV mean and SUV max values. However some differences could be observed in some areas, like in the heart (see Fig. 3 a and b). Such differences could be explained by the impact of the circulation time on the SUV values in such sensitive areas. Minor effects are seen which could have arisen because we used an approximate attenuation correction map instead of the CT map (gold standard). This is one of the limitations of this study. Further investigations need to be performed to compare the same PET images from the MR-PET scanner with both attenuation correction methods: the CT map and the approximate MR-derived map. This is currently under investigation.

In conclusion, multimodality imaging enhances the power of the separated modalities by automatic combination of functional and anatomical information. The use of an MR-PET camera instead of a PET/CT camera not only reduces the extra radiation dose to the patient but also offers higher soft tissue contrast, allowing better visualization of the underlying disease, of particular importance in neurology, cardiovascular disease or oncology for instance. MR-PET offers the possibility of accurately combining functional and excellent anatomical information of the areas under investigation, and hence helping determining the clinical diagnosis and the patient's treatment. Finally, we have shown in this study the possibilities of FDG-PET imaging with the new combined Whole-Body MR-PET scanner and its qualitative and quantitative comparative results with a conventional PET/CT system.

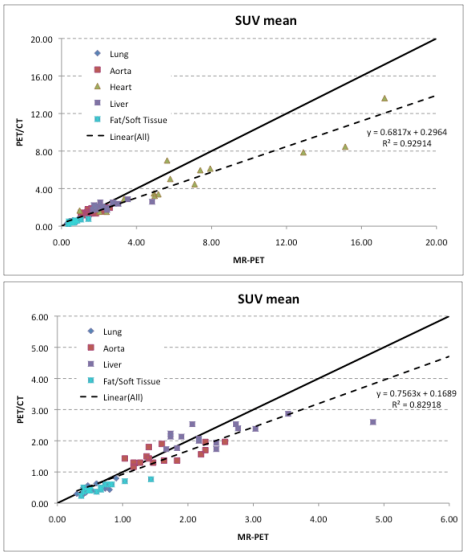

Figure 3: Correlation of MR-PET vs. PET/CT SUV mean values for the different tissue-organs (left) and the same data excluding the heart (right).

References

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