

A PET Optimized 16-Element Anterior Array Coil for 3T Simultaneous MR/PET System

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Introduction

The integration of magnetic resonance imaging (MR) and positron emission tomography (PET) can provide useful information for clinical diagnosis and investigation. Integrated MR/PET scanner simultaneously delivers excellent soft tissue contrast, high spatial and temporal resolution of anatomic and metabolic information. While the RF surface coil design today is well established in MRI [1], its use in an integrated MR/PET is technically challenging. The RF coil that is placed on the patient's body to have optimal MR performance is at the same time in the FOV of PET. Thus, all RF coils need to be optimized for PET-transparency. While the PET signal attenuation characteristics of a rigid and fixed RF coil such as a head coil can be compensated by attenuation correction (AC) method, flexible and floating coils such as anterior array RF coil cannot be easily corrected. Therefore, the flexible and moving RF coils need be designed as PET-transparent as possible. In this study, we designed the 3T 16-element flexible anterior array RF coil for torso and cardiac imaging to minimize the interference with γ -ray detection from PET detectors while maintaining MR performance.

Methods

The major criteria for the optimization of a PET-compatible 3T anterior array (AA) coil are 1) to arrange the coil components to avoid attenuating material on opposite sides of the patient space, 2) to design PET transparent components (cable, cable balun, decoupling and feedboards) and 3) to reduce the thickness of the coil covers.

The feedboards and decouplers were staggered in the coil (Fig. 1 right) and their long axes were tangential to the emission source to reduce the attenuation. The 18-ch micro coaxial output cable was replaced by the new flat cable with new cable balun design and the components of feedboards and decouplers were optimized for PET transparency. The feedboard and decoupler housings were developed and made of 3-D printed Lexan 940. The thickness of housing covers was reduced by ~52% of the GEM AA housing covers. This thickness of formers was chosen for strength, rigidity and PET transparency. The abdomen coverage was achieved by 4 x 4 element design and the coil was constructed using flexible polyimide artworks (Fig. 2).

Each element was tuned to 127.73MHz and matched to 50 ohms. The phased array elements show good isolation. The Q ratio of unloaded and loaded was ~5. MR performance was measured by comparing the SNR to the GEM Anterior array coil. Three axial slices images of unloaded five sectional torso phantoms were acquired from GEM anterior array and MR/PET anterior array coils on a 3T/70 cm G.E. 750w scanner. The SNR of each of the images was computed by acquiring separate signal and noise scans and dividing the signal mean over a circle of 6cm diameter at 10cm area on AP direction by the noise SD over a 20cm diameter circle. PET performance [2] were measured by calculating sensitivity loss over five 15cm regions that covered the entire coil lengths in the S-I direction. Scans were acquired with GE's Discovery PET/CT 600 scanner. A cylindrical phantom of 21.2cm diameter and 28.98cm height filled with ⁶⁸Ge was used to calculate the average sensitivity loss over the each bed.

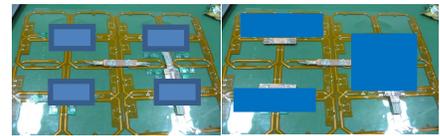


Fig. 1: Placements of GEM anterior array FDs (left) and MR/PET anterior array FDs (right)

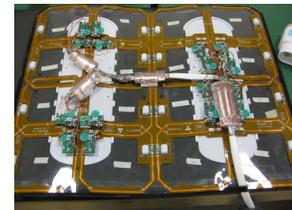


Fig. 2: Construction of MR/PET anterior array coil

Results

The average SNR for MR/PET anterior array coil is ~2.5% better than GEM Anterior array coil (Table 1). Table 2 shows sensitivity loss and mean error of the MR/PET Anterior array coil as compared to the GEM Anterior array coil which was designed for MR only imaging for worst PET bed. We observed a 54% improvement on average sensitivity loss. The mean error maps (%) for both coils are shown in Fig 3.

Slice	SNR of MR/PET AA	SNR of GEM AA
S110	142.90	138.31
S0	135.21	131.21
I110	143.54	142.40

Table1: SNR comparison between MR/PET AA coil and GEM AA coil

Conclusions

The 3T 16-element PET optimized anterior array coil shows significant improvement on sensitivity loss with good MR performance. Future work will include scanning human volunteers to qualify the improvements.

Coil	Sensitivity Loss (in %)	Mean Error (in %)
MR/PET AA	4.65	5.4
GEM AA	10.13	11

Table2: Sensitivity loss (%) and mean error (%) for MR/PET AA coil and GEM AA coil.

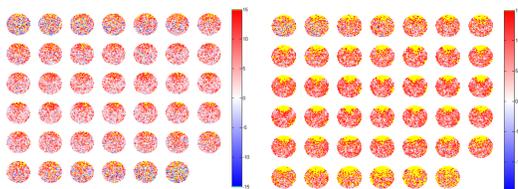


Fig 3: Mean error maps for MR/PET AA coil (left) and GEM AA coil (right).

References

- [1] Roemer, P.B. et al. 1990, *MRM* 16:2, 192-225.
- [2] G Delso et al. 2010 *Phys. Med. Biol.* 55, 4361-4374.