High PET Sensitivity of SIGNA PET/MR and Q.Static Elevate Clinical Confidence

In October 2015, Michael Soussan, MD, PhD, began evaluating a SIGNA™ PET/MR system newly installed at CEA Service Hospitalier Frédéric Joliot (SHFJ) in Orsay, France. Dr. Soussan compared sensitivity, specificity, and clinical confidence between the new PET/MR and an existing prior generation PET/CT from a different manufacturer in order to better understand the role that PET/MR should play in patient management.

Oncology staging is currently the primary utilization of PET/CT, accounting for approximately 80% of patient scans at CEA-SHFJ. PET/CT is also used for brain exams.

According to Dr. Soussan, a major challenge is to demonstrate the ability of PET/MR to enhance the confidence associated with the interpretation of PET and MR imaging data. The hospital's clinicians currently rely on the interpretation of PET/CT images. He believes demonstrating that PET/MR further increases the certainty with which the physician comes to a conclusion based on the PET and MR images would certainly contribute to a large acceptance of the new system for patient management.

The PET component on the SIGNA PET/MR features a new digital Silicon Photomultiplier (SiPM) detector that is up to three times more sensitive than conventional PET technology. It also features ultra-fast coincidence timing resolution enabling time-of-flight (TOF) reconstruction. With TOF reconstruction, the arrival times of each coincident pair of photons are more precisely detected, and the time difference between them is used to localize the PET signal accurately. TOF leads to improved PET image quality with higher structural detail and improved signal-to-noise ratio.

As of April 2016, the hospital has scanned 150 patients who underwent both a PET/CT and PET/MR.

Results

Nuclear physicians were asked to provide their assessment regarding the overall PET image quality (image contrast and resolution) and the ease of interpretation of the PET/MR scans compared to the PET/CT scans.

"Many of the differences we observed in the images are due to the different PET technology between our PET/CT and PET/MR scanners, demonstrating the huge progress made in PET detector technology over the years, by taking advantage of time-of-flight, enhanced reconstruction including point spread function modeling, and scatter recovery," Dr. Soussan says. "The PET/MR clearly demonstrated better contrast, resolution, and image quality over the prior generation PET/CT scanner."

The SiPM detector is a big advancement in technology, he adds, with this new combination of modalities providing improved lesion detectability and more accurate interpretation of the signal.

Motion correction using Q.Static was also evaluated on every patient undergoing a PET/MR at CEA-SHFJ. "We could already see the difference in quantitation and lesion appearance, but the most important point is that we can use it routinely, which will help us make a comprehensive assessment of the clinical benefit of motion compensation. Using PET/MR, motion correction can now enter the clinical practice, and it is possible to use it for every patient. With the high PET sensitivity, we can use Q.Static retaining about half the signal and still have imaging perfectly suitable for interpretation without increasing the acquisition duration," he says.

"Improving the spatial resolution and image quality of PET is very important—it helps make the technique more precise and efficient than with prior generation technology," Dr. Soussan adds. He is hopeful that a higher PET sensitivity combined with multiparametric MR can help clinicians address the issue of false positives and false negative lesions when these situations occur in clinical practice.

Case 1

A 75-year-old woman with colorectal cancer, treated six months earlier with adjuvant chemotherapy, referred to PET/CT (non TOF PET/CT system: 371 MBq, 75 min post IV, 4 min/bed position, no PSF modeling in reconstruction) followed by PET/MR (100 min post IV, 4 min/bed position, TOF and PSF modeling reconstruction).

The improvement in sensitivity leads to homogenous liver and better contrast recovery of small lesions. This case shows that PET/MR enables a precise staging of liver metastasis, improving the therapeutic strategy.

Case 1

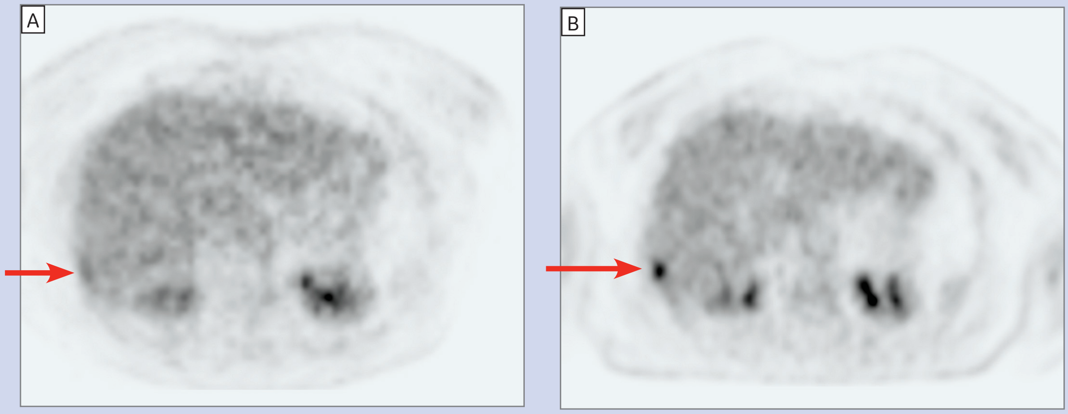

Figure 1. The PET image from (B) the PET/MR shows better conspicuity of one liver sub capsular lesion, only slightly visible in (A) the PET image from the PET/CT.

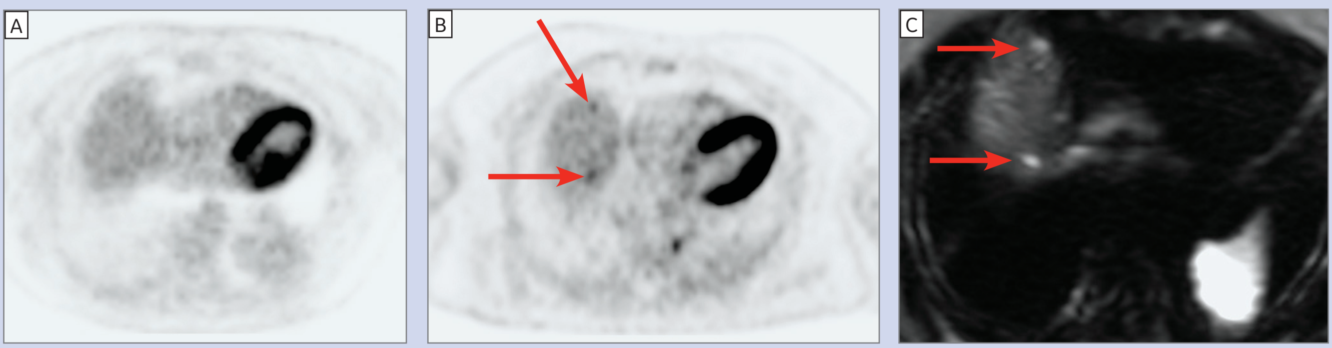

Figure 2. Illustration of the higher diagnostic confidence with multi-modality imaging: Additional liver metastases are slightly visible on (B) the PET image from the PET/MR, not visible on (A) the PET image from the PET/CT, and clearly seen on (C) the MR diffusion weighted image.

Case 2

A 76-year-old woman with initial diagnosis of well-differentiated, midgut neuroendocrine tumor with lymph nodes and liver metastasis. The patient was scanned with ^{18}F-DOPA PET/MR (245 MBq, 94 min post IV, 6 min/bed, 4 beds, TOF and PSF modeling reconstruction). Q.Static was employed for respiratory gating. ■

Case 2

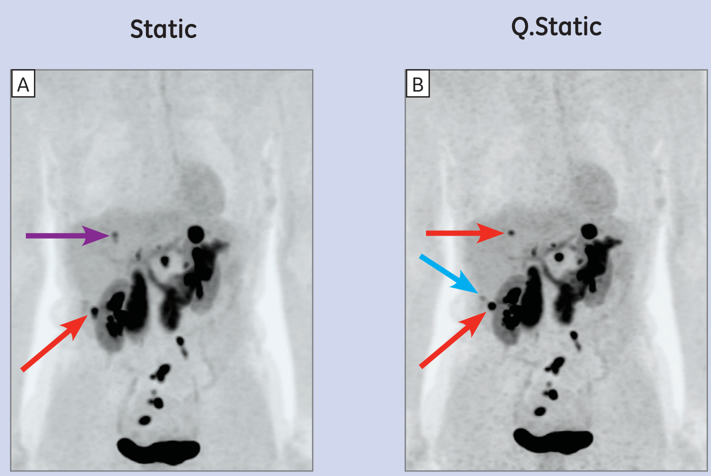

Figure 3. The impact of respiratory gating with Q.Static can be clearly seen in this patient case. (A) In the static images, two right liver lesions are blurred (purple and red arrows) and the upper lesion almost appears as two lesions (purple arrow, SUVpeak: 1.9, metabolic volume [42% threshold]: 3 cm^3). (B) With Q.Static reconstruction, the images are clearer with an increase in lesion conspicuity for a diagnosis of two lesions (red arrows). The contrast of the upper lesion is enhanced (SUVpeak: 2.2, metabolic volume [42% threshold]: 0.8 cm^3). Furthermore, in the Q.Static image, a third lesion previously poorly delineated was also identified (blue arrow).