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Short Acquisition Times with General Purpose CZT SPECT/CT System

Saitama Medical University's initial experience

In July 2017, Saitama Medical University implemented Discovery™ NM/CT 670 CZT, the world's first general-purpose SPECT/CT powered by cadmium zinc telluride (CZT) technology. This next-generation CZT semiconductor detector has been shown in published studies to deliver exceptionally improved performance relative to conventional SPECT systems.[1,2]

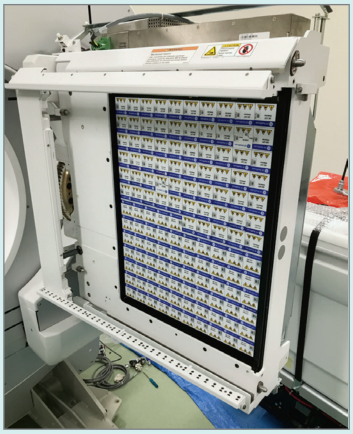

Figure 1. The CZT detector without collimator. CZT detector modules are aligned to the edge of the frame and the brain reach is 2.5 cm.

Initially, CZT was only available in a dedicated cardiac SPECT imaging system, Discovery™ NM530c, that delivered short acquisition times that could decrease the patient's exposure to dose. Continued development of CZT-based cameras in conjunction with the growth in hybrid imaging led to the introduction of Discovery NM/CT 670 CZT.

According to Ichiro Matsunari, MD, PhD, Professor, Nuclear Medicine Department, Saitama Medical University Hospital in Moroyama, Saitama, Japan, "We found that with each photon directly converted into an electrical signal, CZT reduces the signal loss and noise inherent in conventional SPECT/CT, recovering lost spatial and energy resolution.

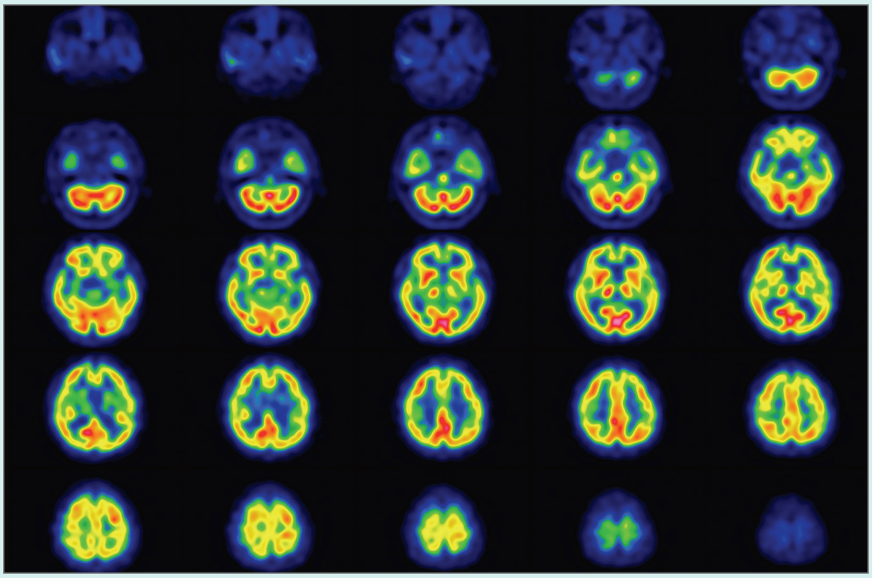

Figure 2. Brain perfusion image with ^{99m}Tc-ECD.

Using the Lister tool in bone SPECT imaging, high image quality can be obtained even in acquisitions

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at half the conventional time." The Lister tool enables retrospective resampling of data to illustrate various acquisition protocols.

CT provides additional anatomical information to assist with further investigation. Fusing the SPECT and CT images is accomplished without positional deviation. Additionally, Q.Metrix provides SPECT SUV values to evaluate changes over time, which helps assess patient prognosis and response to treatment.

"In neurological imaging, we found that since the digital detector does not use photomultiplier tubes, the frame is 5 cm smaller than in conventional cameras, enabling improved imaging proximity to the patient," says Dr. Matsunari. This further increases resolution (Figure 2). In this example, the brain is imaged at the rotational radius of the detector at approximately 13 cm enabled by the 2.5 cm detector frame (Figure 1).

"We see the excellent spatial resolution depicting blood flow using ^{99m}Tc-ECD SPECT," he adds.

Further, with the Lister tool he is exploring myocardial perfusion imaging acquisition times while maintaining sufficient image quality for diagnosis. Lister tool enables the acquired list-mode data to be manipulated to remove number of counts or change the energy windows. As an example, the conventional SPECT acquisition is 7.5 minutes; using the Lister tool, Dr. Matsunari explored shortening it to 3.8 minutes and then to 1.9 minutes (Figure 3).

"We also found that cardiac SPECT imaging with a CZT detector provides us with the images that we need even when using a low dose or short imaging acquisition time," Dr. Matsunari explains. He and his colleagues are currently evaluating the use of Discovery NM/CT 670 CZT in cardiac imaging and comparing the results to a dedicated cardiac system.

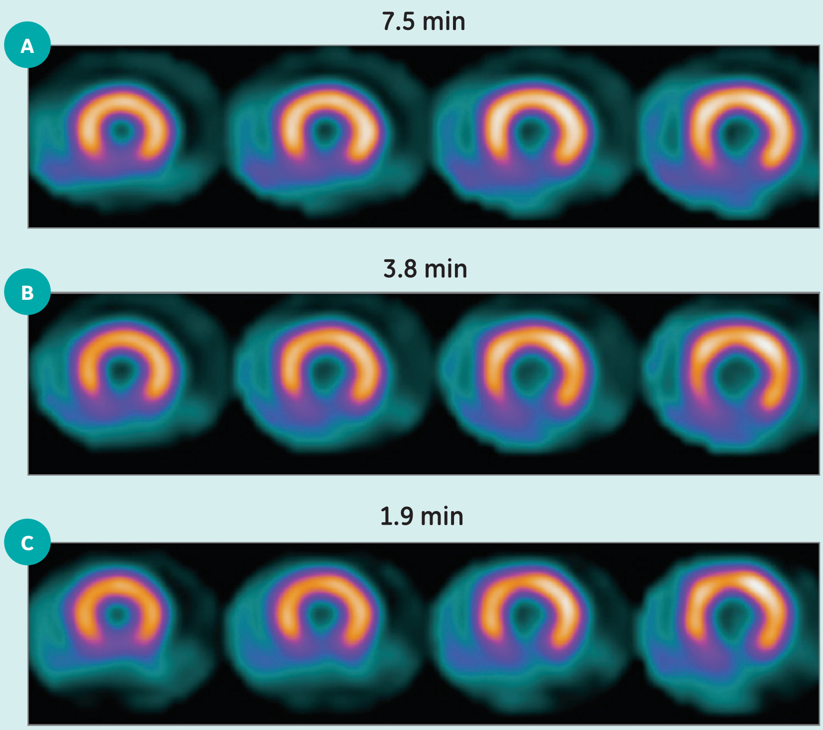

Figure 3. Myocardial perfusion short axis images (^{99m}Tc-tetrofosmin) with CT attenuation correction created in scan times of (A) 7.5 min, (B) 3.8 min and (C) 1.9 min.

"In cases of fatal arrhythmia and sudden death, research suggests that sympathetic nerves in the myocardium are almost always involved," Dr. Matsunari explains.

"Therefore, in cardiac SPECT imaging it is important to detect sympathetic nerve abnormality in isolation and also in the myocardium. However, ^{123}I-MIBG myocardial SPECT has traditionally had poor image quality, making it difficult to evaluate the myocardium and detect a defect in the lower wall due to attenuation. By

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using CT, similarly to myocardial blood flow SPECT, it is possible to perform attenuation correction which improves our image quality and diagnostic confidence." Figure 5 illustrates the impact of CTAC on image quality.

"Discovery NM/CT 670 CZT performed well in our institution. We were particularly pleased with the excellent spatial resolution and clear image quality of brain SPECT imaging. In cardiac imaging, clear images were obtained especially when applying the attenuation correction. And with the Lister tool, we generate diagnostic quality data at significantly shorter acquisition times. We will continue to further investigate short acquisition times and dose reduction with this system, at which point we plan to implement it into our routine protocols," concludes Dr. Matsunari. ■

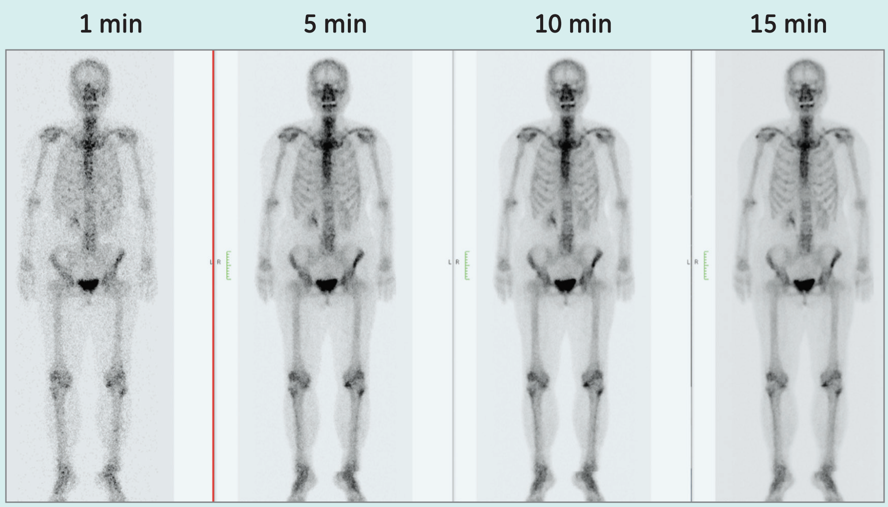

Figure 4. In bone SPECT imaging, high image quality can be obtained even in acquisitions at half the conventional time.

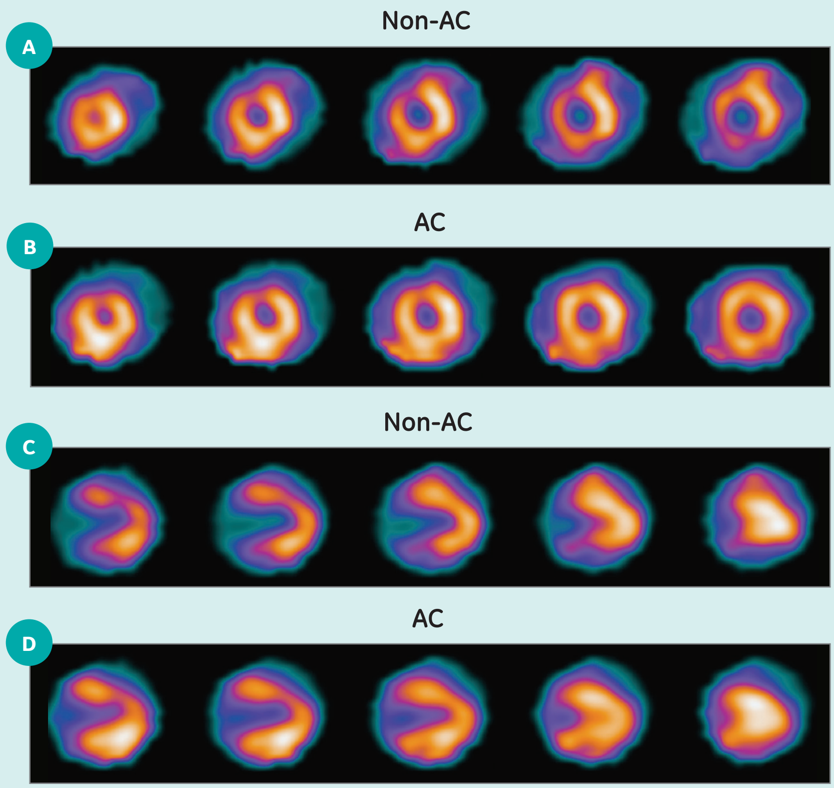

Figure 5. ^{123}I-MIBG images, same patient as shown in Figure 4. (A) Short axis without AC; (B) short axis with AC; (C) vertical long axis without AC; (D) vertical long axis with AC.

References

1. Buechel RR, Herzog BA, Husmann L, et al. Ultrafast nuclear myocardial perfusion imaging on a new gamma camera with semiconductor detector technique: first clinical validation. Eur J Nucl Med Mol Imaging. 2010 Apr;37(4):773-8.

2. Herzog BA, Buechel RR, Katz R, et al. Nuclear myocardial perfusion imaging with a cadmium-zinc-telluride detector technique: optimized protocol for scan time reduction. J Nucl Med. 2010 Jan;51(1):46-51.