



Assessing CFR with a CZT-based Detector System

The assessment of coronary flow reserve (CFR) is an important indicator for the diagnosis of coronary artery disease and evaluation of treatment regimens. It is a measurement of the heart's ability to improve blood flow in response to maximal exercise, which can be reduced due to conditions such as atherosclerosis and stenosis.

Various imaging techniques have been utilized for measuring CFR, including SPECT, Doppler echocardiography, PET and digital subtraction angiography with coronary catheterization. At Fondazione Toscana-CNR Gabriele Monasterio for Medical Research and Public Health, the Discovery™ NM530c camera, featuring cadmium zinc telluride (CZT) detectors, has been routinely utilized for cardiac imaging studies since its implementation in 2010. Under the guidance of Alessia Gimelli, MD, Department Head/Chief of the Nuclear Medicine Department and a nuclear cardiologist and nuclear medicine physician at Fondazione Toscana-CNR (Pisa, Tuscany, Italy) the center has recently been exploring the clinical utility of CFR with this system.

Dr. Gimelli has been evaluating patients with nuclear medicine cameras for over 20 years. The evaluation of CFR is very important in the diagnostic work-up of cardiac patients. Until recently, CFR studies on the CZT system were used only in a research environment.

"We perform most of our cardiac studies with the CZT camera," explains Dr. Gimelli. "So the possibility to perform CFR with CZT is very important in the management of our cardiac patients."

Approximately 1,400 nuclear cardiac studies are performed each year. While many of these are perfusion exams, the

department also conducts two to three cardiac ¹²³I-MIBG studies each week for the evaluation of sympathetic innervation abnormalities.

Low dose is an important benefit of Discovery NM530c for cardiac patients. According to Dr. Gimelli, for a complete stress/rest perfusion study, 3-4 mCi of ^{99m}Tc Sestamibi is injected for stress and 8-10 mCi is injected for the rest study. Stress/rest study is lower than 5 mSv, which is well below the recommended ASNC guidelines.

"As we routinely use stress-only exams unless the results are positive, we can get down to 1.5 mSv" adds Dr. Gimelli.

"With the CZT system, dose and acquisition times can be lower," Dr. Gimelli explains. She can perform a typical 20 minute SPECT study on the CZT camera in 10 minutes or less, with a lower injected dose.

"This makes a big difference for our patients. In general, many patients are not comfortable during a 20 minute acquisition, and artifacts due to a patient's movement could be introduced," she adds. "Also, the image quality of the CZT detector study is much better than on conventional NaI technology."

Improved image quality on Discovery NM530c is directly related to the increase in signal detection efficiency. According to Dr. Gimelli, there is greater pronouncement of the defect and border, which enhances her ability to detect coronary artery disease (CAD). Compared to traditional SPECT, with the CZT detector based system she can better visualize the inferior wall with the increase in signal and image quality. "We now

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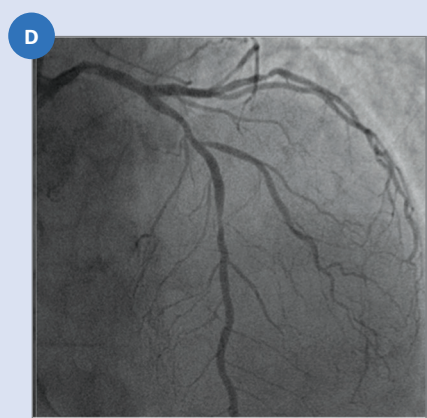
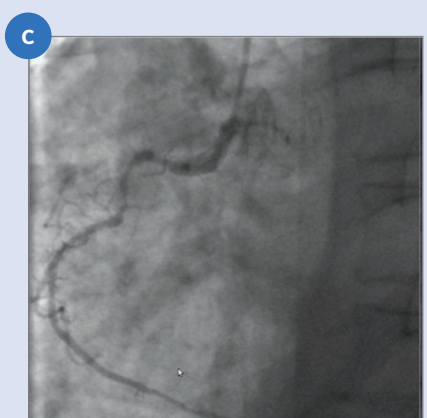
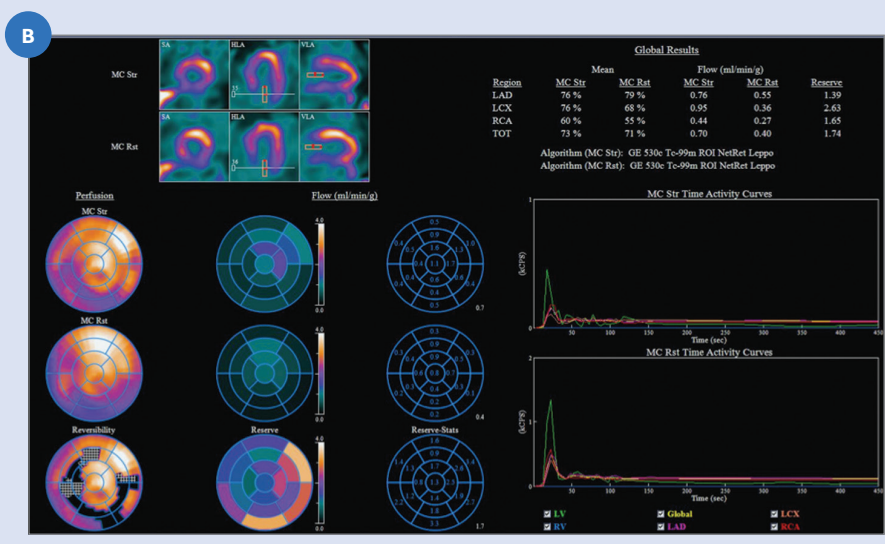
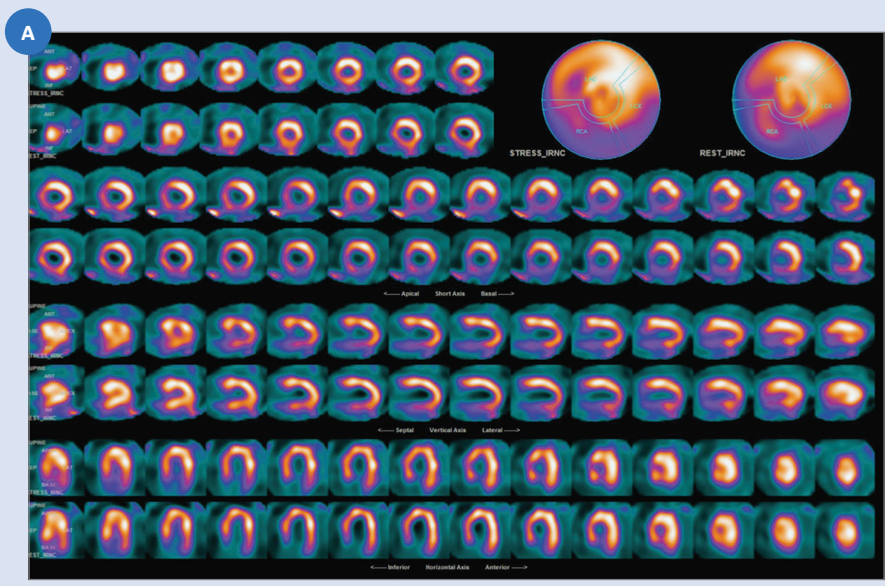


Figure 1. A 67-year-old man with familial hypercholesterolemia and atypical angina. Exercise stress test was not conclusive. The subject was referred for myocardial perfusion imaging on the Discovery NM530c camera. (A) The images were dynamically acquired for evaluating MBF and CFR. (B) The qualitative analysis showed post stress perfusion abnormalities in the inferior wall and in the septal wall (two vessel disease). The MBF and CFR analysis detected the presence of significant absolute MBF alteration in LAD territory as well as in the RCA territory, confirmed by (C, D) coronary angiography.

Global Results		
Mean		
Region	MC Str	MC Rst
LAD	76%	79%
LCX	76%	68%
RCA	60%	55%
TOT	73%	71%
Flow (ml/min/g)		
MC Str	MC Rst	Reserve
0.76	0.55	1.39
0.95	0.36	2.63
0.44	0.27	1.65
0.70	0.40	1.74



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have greater confidence that we are sending the appropriate patients to the cath lab,” she adds.

“With CZT, the accuracy in detection of CAD is improved,” Dr. Gimelli says. “The borders are well defined and the extension and severity of ischemia can be detected, not only in the evaluation of one or two vessel disease, but also in cases of three-vessel disease.”

Using this approach, Fondazione Toscana-CNR has reduced the need for additional imaging tests prior to coronary angiography to only 5% of patients. As a result, most patients with suspicion of CAD undergo a complete functional myocardial evaluation with only Discovery NM530c.

Initial CFR experience with CZT

As mentioned, Dr. Gimelli has recently begun using the CZT system for CFR studies. “Up to this point, the advantage of cardiac PET was the ability to quantify blood flow. In her experience, CZT could be used in the future in clinical routine for absolute myocardium evaluations including CFR. On average, the department now conducts approximately 2 CFR studies on the CZT camera each week.

“The technology in CZT is completely different than conventional SPECT as the semiconductor material and the geometry of the camera allow the acquisition of images in a three-dimensional fashion which allows us to perform a dynamic study with very good temporal resolution.” Dr. Gimelli explains. “That is the only way you can have an evaluation of absolute myocardial blood flow.”

The ability to perform CFR on Discovery NM530c is important for several reasons. First, cardiologists utilize the fractional flow reserve (FFR) performed during coronary catheterization to determine whether or not to perform revascularization of stenosis in an artery. To previously obtain this information non-invasively required PET imaging. However, Dr. Gimelli points out that in Europe, PET is mainly dedicated to oncology studies, not cardiology. Therefore, the opportunity to perform CFR non-invasively is very limited in her institution and many others across the continent.

“The possibility to perform CFR with CZT to obtain this absolute myocardial cut off value is one important way to reduce the use of invasive (diagnostic) coronary angiography,” Dr. Gimelli says. “It could also potentially detect microcirculation abnormalities or the efficacy of therapy in patients with CAD. Further, in patients with three-vessel disease, CZT could be used to analyze the amount of ischemia in each vessel, and finally, the functional evaluation of intermediate stenosis detected by non-invasive or invasive coronary angiography. There are many opportunities with the CZT technology that can help us provide the information to cardiologists that they need for clinical decision making and patient management.”

When using CZT for CFR, she notes that it is important to use pharmacological and not exercise stress, due to the fact that the dynamic acquisition must start at the beginning of the tracer injection.

Dr. Gimelli will be analyzing comparative data between PET, CZT and FFR to further explore these capabilities and expects to have more data mid-2018. ■