Noninvasive Angiography Is a Reality With CT

BY ROBERT FINN
San Francisco Bureau

SAN FRANCISCO — With computed tomography angiography, "patients literally go home with a Band-Aid and a bottle of water" after just 20 minutes, Matthew J. Budoff, M.D., remarked at a cardiovascular imaging conference sponsored by the American College of Cardiology.

With high sensitivity and specificity and images that rival the resolution obtainable with traditional coronary angiography from the catheterization lab, CT angiography will allow many more patients to avoid an invasive procedure, said Dr. Budoff of Harbor-UCLA Medical Center, Torrance, Calif.

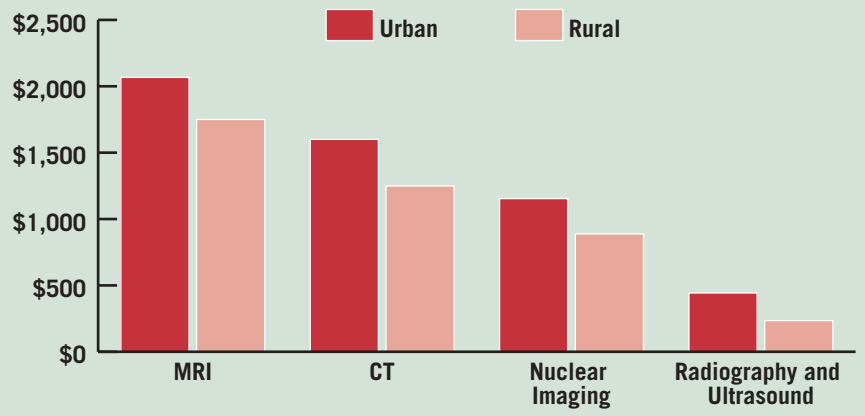
After an injection of 80-100 mL of nonionic iodinated contrast solution, up to 4,000 two-dimensional images can be obtained within 20-30 seconds as the patient holds his or her breath. The entire procedure takes 20 minutes, and interpretation takes another 10 minutes.

Sophisticated workstations assemble the stack of 2D images into a three-dimensional reconstruction. Interpretations are made on the basis of the 3D reconstruction with reference to the 2D images.

Dr. Budoff started working with CT angiography in the mid-1990s. In those days it took 3 weeks of full-time computation to assemble a single 3D reconstruction. This same function takes just 30 seconds today.

DATA WATCH

Mean Charges for Diagnostic Imaging in Florida Hospitals



Note: Based on 2002 data from the Florida Hospital Uniform Reporting System.
Source: J. Am. Coll. Radiol. 2005;2:511-9

And these workstations allow the cardiologist to rotate the heart image in three dimensions, to zoom in to interesting features, and to easily reference the original 2D data from any point of interest.

The initial studies of four-slice CT angiography revealed the limitations of this early technique. Only 30% of patients had all three major arteries available for analysis, and in detecting stenosis the sensitivity was just 58% with 76% specificity.

Now, as 16-slice and even 64-slice CT angiography become available, the sensitivity and specificity have improved considerably. Studies have calculated sensitivities as high as 97% and specificities as high as 94%.

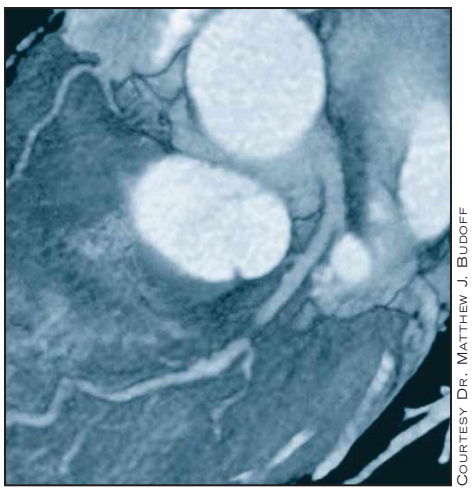
Most important, the negative predictive value is 98%-100%. "The benefit of CT angio is that when the coronaries *look* normal, the coronaries *are* normal," Dr. Budoff said.

The temporal resolution of the CT images is about 175 milliseconds, so reducing the heart rate to below 60 beats per minute is important for accuracy and interpretability. Most centers use 100 mg metoprolol 1 hour prior to the study and/or a 5-mg intravenous metoprolol push every 5 minutes until the patient achieves a slow heart rate.

A regular rhythm is also important. With multiple detectors obtaining images at specific parts of the heart cycle, the modality reaches an effective frame speed of 15 images per second. This is slower than the cath lab, but fast enough that the images are free of motion artifact.

CT angiography may be the best technique for imaging the results of bypass grafting as the anastomoses are clearly visible. Other clinical indications for CT angiography are in cases of equivocal results following stress testing; to evaluate patency post angioplasty, post stent, and post bypass surgery; in cases of congenital abnormalities and anomalous coronaries; before and after atrial fibrillation ablation; and before placing a biventricular pacer.

CT angiography is not without its disadvantages, however. It's not very good for visualizing vessels with diameters less than 1.5 mm. It is subject to artifacts from extensive calcification, stents, or extensive clips after bypass grafting. And it subjects patients to a relatively high dose of radiation—about 9.3-11.3 mSv, compared with 2.1-2.3 mSv for the cath lab and 0.1 mSv for a chest x-ray. ■



COURTESY DR. MATTHEW J. BUDOFF

CT angiography reveales high-grade stenosis (dark area) in the mid-left anterior descending coronary artery.

KEVIN FOLEY, RESEARCH

Quantitative SPECT Aids Risk Estimates, Treatment Decisions

BY ROBERT FINN
San Francisco Bureau

SAN FRANCISCO — Quantitative nuclear cardiology allows for highly sensitive, specific, and reproducible estimates of a patient's risk and assists in the decision of who should be sent for revascularization, Daniel S. Berman, M.D., said at a cardiovascular imaging conference sponsored by the American College of Cardiology.

When quantitative techniques are used with single proton emission computed tomography (SPECT), the results are operator independent, said Dr. Berman of Cedars-Sinai Medical Center, Los Angeles. A quantitative SPECT assessment of myocardial perfusion and function reduces the reliance on expert observers, standardizes results from center to center, facilitates serial assessments, and ultimately improves patient outcomes.

When quantitative techniques are used with SPECT, the results are operator independent.

DR. BERMAN

The technology produces reliable assessments of a number of important parameters of cardiac function. (See box.) And numerous studies have shown how these parameters relate to cardiac risk.

For example, pooled data from more than 17,000 patients show that those with a normal stress myocardial perfusion SPECT had only a 0.6% chance of suffering cardiac death or a nonfatal MI over a mean follow-up of 27 months. This low rate of cardiac events is especially impressive because these were patients with known or suspected coronary artery disease.

Measurements Possible With Quantitative Cardiac Perfusion SPECT

Percent hypoperfusion
Percent reversibility
Lung-to-heart ratio
Transient ischemic dilatation
Left ventricular mass
Left ventricular ejection fraction
End diastolic volume
End systolic volume
Wall motion
Wall thickening
Peak filling rate

Source: Dr. Berman

This study included patients who were under either exercise or pharmacologic stress. According to another study, a normal stress myocardial perfusion SPECT has less prognostic value if the patient fails to reach at least 70% of the predicted maximal heart rate (PMHR) during exercise. Among more than 5,000 patients, the cardiac event rate for patients who failed to reach 70% PMHR was more than three times that of those who reached 70%-100% PMHR.

Patients who are unable to reach 70% PMHR during exercise need to undergo myocardial perfusion SPECT with pharmacologic stress, Dr. Berman said.

The presence of diabetes is another factor that modifies a patient's risk after myocardial perfusion SPECT. For any given summed stress score (SSS)—an estimate of the overall size and severity of a perfusion defect during stress—nondiabetics have the lowest level of risk, insulin-dependent diabetics have the highest level of risk, and non–insulin-dependent diabetics have an intermediate risk.

SSS alone isn't enough, however. The summed difference score, which subtracts the summed rest score from the SSS, is a more reliable measure.

Better still is to normalize these scores based on the maximum possible score. This yields measures of percent myocardium perfused that are independent of the specific SPECT system employed. When applied to the summed difference score, the percent myocardium perfused is a measure of ischemia.

This measure of ischemia is important in deciding whether to refer patients to revascularization or to treat them with medical therapy. On the one hand, studies have shown that patients with extensive ischemia have a much lower risk of cardiac death with revascularization than with medical therapy. On the other hand, patients with less than about 10% ischemia have a lower risk of cardiac death with medical therapy.

Despite its value, cardiac perfusion SPECT does have a number of limitations, Dr. Berman said. Because the test detects only hydrodynamically significant lesions, it won't pick up early atherosclerosis. It also won't pick up some of the patients at the very highest risk, those with a balanced reduction in perfusion. And it may underestimate the extent of ischemia and cardiovascular disease as well as the amount of viable myocardium. ■

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