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Diagnostic Testing

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A total of 857 abstracts were submitted to the Diagnostic Testing category. Among these, 276 were accepted for presentation and comprised 17% of all presented abstracts at the ACC.06 Scientific Sessions. In addition, several other categories, such as heart failure, ischemia and infarction, congenital heart disease, and valvular disease, received numerous abstracts with a major focus on noninvasive imaging. Within the diagnostic testing category, the presented abstracts may be divided into five subgroups: cardiovascular magnetic resonance (CMR), cardiac computed tomography (CT), nuclear cardiology, echocardiography, and exercise stress testing. The highlights selected represent only a small fraction of the high-quality, important abstracts that were presented in this category.

CARDIOVASCULAR MAGNETIC RESONANCE

One theme that is growing in importance for this modality is the need to transition from pilot studies that involve small numbers of patients to larger population-based studies. One example of the latter was presented by Arai et al. (1), who evaluated the prevalence of recognized and unrecognized myocardial infarction (MI) in the ICELAND MI substudy of the Age, Gene/Environment Susceptibility (AGES-Reykjavik) study. The AGES-Reykjavik study is characterizing approximately 6,000 people 67 to 95 years of age under the aegis of the U.S. National Institute on Aging and the Icelandic Heart Association.

The substudy involved a random sample of 447 of the AGES-Reykjavik patients who underwent delayed contrast-enhanced cardiovascular magnetic resonance (DE-CMR) (1). The investigators found that the prevalence of MI was 9.4% according to hospital records but only 6.7% by electrocardiogram (ECG) analysis. In comparison, DE-CMR suggested a prevalence rate that was considerably higher at 22%. The investigators concluded that magnetic resonance imaging reveals a substantially higher overall prevalence of MI than predicted from the literature and that DE-CMR was significantly more sensitive in detecting infarction than clinical and/or ECG criteria. Although these results are quite provocative, an essential next step would be to provide evidence that unrecognized MI, as detected by DE-CMR, has prognostic significance.

Given the relative infancy of CMR, there is a paucity of studies regarding its prognostic value. At this meeting, Dall'Armellina et al. (2) presented one such study reporting on the prognostic value of dobutamine stress CMR. The authors focused on a cohort of 240 patients who were not well suited for transthoracic echocardiography (i.e., poor echocardiographic windows) and were found at baseline to have resting left ventricular (LV) wall motion abnormalities. The finding of increasing LV dysfunction during dobutamine CMR was associated with adverse cardiac prognosis in terms of cardiac death or nonfatal MI after a mean follow-up time of 5 ± 1 years.

Already widely appreciated as clinically useful in assessing patients with ischemic heart disease, CMR, particularly DE-CMR, is emerging as a unique tool for the evaluation of nonischemic cardiomyopathies. Valente et al. (3) assessed the relationship between myocardial fibrosis detected by DE-CMR and diastolic function in patients with hypertrophic cardiomyopathy. They reported that the presence of hyperenhancement (fibrosis) was associated with earlier age of symptom onset, greater septal wall thickness, and several indices of diastolic dysfunction as measured by Doppler echocardiography. A restrictive filling pattern, for example, was observed in 35% of patients with hyperenhancement versus 7% in patients without hyperenhancement. The authors speculated that DE-CMR may provide insight into the pathogenesis of diastolic dysfunction in patients with hypertrophic cardiomyopathy.

Continuing the theme of new CMR applications, Sanz et al. (4) performed DE-CMR in 38 patients with known or suspected pulmonary hypertension (PH). In these patients, who also underwent right heart catheterization on the same day, hyperenhancement (fibrosis) frequently was evident in a peculiar location: in the anterior and inferior ventricular septum where the right ventricular free wall inserts.

This unusual pattern is distinct from that typically observed in patients with coronary artery disease (CAD) and previous MI. This non–CAD-type pattern identified the presence of PH with a sensitivity and specificity of 94% and 86%, respectively. Moreover, the extent of hyperenhancement was correlated significantly, with the mean pulmonary artery pressure measured invasively. The authors concluded that hyperenhancement of the ventricular septum at the right ventricular insertion points is common in PH and the extent of hyperenhancement is related to the severity of PH.

COMPUTED TOMOGRAPHY

The potential clinical roles of multidetector computed tomography (MDCT) was a central theme. Raff et al. (5) examined the utility of MDCT in 200 patients with low-risk acute chest pain. Patients were assigned randomly to either immediate 64-slice CT coronary angiography or standard-of-care evaluation (radionuclide stress testing). Patients undergoing CT angiography were discharged for

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Abbreviations and Acronyms

2D	= two-dimensional
3D	= three-dimensional
AGES-Reykjavik	= Age, Gene/Environment Susceptibility-Reykjavik trial
CAD	= coronary artery disease
CMR	= cardiovascular magnetic resonance
CT	= computed tomography
DE-CMR	= delayed contrast-enhanced cardiovascular magnetic resonance
ECG	= electrocardiogram
ICD	= implantable cardioverter-defibrillator
LBBB	= left bundle branch block
LV	= left ventricular
LVEF	= left ventricular ejection fraction
MADIT-II	= Multicenter Automatic Defibrillator Implantation Trial-II
MDCT	= multidetector computed tomography
MI	= myocardial infarction
PH	= pulmonary hypertension
PET	= positron emission tomography
SPECT	= single-photon emission computed tomography

luminal stenosis <25%, referred to invasive X-ray angiography for stenosis >70%, and crossed over to stress testing for intermediate lesions or if the CT examination was uninterpretable.

There was no difference in 90-day major adverse coronary event rates for either the CT angiography or standard-of-care strategies. However, patients undergoing CT angiography had a 43% shorter length of stay (12.5 h vs. 22.1 h; $p < 0.001$) and a 15% lower cost of care ($1,586 vs. $1,872; $p < 0.001$). Of interest, more CT angiography patients underwent invasive coronary angiography (11 vs. 3), with the result that CT angiography correctly predicted catheterization results in 10 of 11 patients whereas standard-of-care predicted correct results in 2 of 3 patients. The authors concluded that CT angiography can rapidly and safely triage low-risk acute chest pain patients while reducing length of stay and cost of care.

In another evaluation of the utility of 64-slice MDCT, Rubinshtein et al. (6) studied 133 consecutive patients with chest pain and negative or equivocal exercise treadmill tests. multidetector CT identified obstructive CAD (≥50% stenosis) in 25% of the patients with negative exercise stress tests, whereas MDCT excluded CAD in more than one-half of those patients with equivocal exercise stress tests (Table 1). Invasive angiography confirmed the MDCT findings of obstructive CAD in 91% of patients. Thus, the conclusion was that MDCT appears to be an excellent tool for improving diagnostic accuracy in patients with chest pain, moderate pretest probability of CAD, and negative or equivocal findings on exercise stress testing.

A number of abstracts examined the safety of MDCT with regards to radiation exposure. Einstein et al. (7) sought to determine the effective radiation dose and lifetime attributable risk of cancer for patients undergoing coronary imaging using 16-slice MDCT. Effective radiation doses and organ equivalent doses were estimated by actual scan parameters and computer modeling, with lifetime attributable risk determined using models developed in the National Academies' Biological Effects of Ionizing Radiation VII Report.

On average, the radiation dose was 9 mSv, which increased to 11.5 mSv when calcium scoring was included. Radiation doses were comparable with standard nuclear cardiology protocols (Fig. 1). Interestingly, the radiation dose was greater in women than in men (13.5 mSv vs. 11 mSv). The lifetime attributable risk of cancer incidence was estimated to be 1 in 1,600, with a worst-case scenario of 1 in 500. Most of this increased risk was due to lung cancer overall and breast cancer in women. The authors have initiated a similar analysis using 64-slice MDCT, and based on preliminary data, it appears the radiation dose will be approximately 50% higher.

NUCLEAR CARDIOLOGY

In reviewing the nuclear imaging presentations, one notable theme was the growing popularity of hybrid imaging that combines myocardial perfusion imaging with coronary anatomy evaluation using MDCT. The rationale, of course, is that information regarding the presence or absence of myocardial ischemia is different and usually complementary to coronary anatomy. Di Carli et al. (8) studied 100 consecutive patients with low-to-intermediate pretest likelihood of CAD using hybrid imaging that combined stress positron emission tomography (PET) and MDCT (16- or 64-slice). There was a high negative predictive value with MDCT for identifying myocardial regions or patients with myocardial ischemia but, unfortunately, the positive predictive value was quite low (Table 2), only 26% on a per-vessel analysis and 42% on a per-patient analysis. Conversely, a normal stress PET examination was a poor discriminator of patients without subclinical coronary atherosclerosis, only 49% had normal CT angiography. Accordingly, the authors

Table 1. MDCT and Invasive Angiographic Findings After Exercise Treadmill Tests

	≥50% Stenosis on MDCT (% of ETT)	No Significant Stenosis on MDCT (% of ETT)	Confirmation of MDCT by ICA (%)
Negative ETT (n = 76)	19 (25)	57 (75)	18/19 (95)
Equivocal ETT (n = 57)	25 (44)	32 (56)	22/25 (88)
Total (n = 133)	44 (33)	89 (67)	40/44 (91)

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ETT = exercise treadmill test; ICA = invasive coronary angiography; MDCT = multidetector computed tomography.