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MEETING HIGHLIGHTS

Meeting Highlights of the 10th Annual Scientific Sessions of the Society for Cardiovascular Magnetic Resonance and 6th Annual Meeting of the Working Group for Cardiovascular Magnetic Resonance of the European Society of Cardiology

Rome, Italy, February 2–4, 2007

Matthias G. Friedrich, MD, FESC,* Christopher M. Kramer, MD, FACC,† Daniel K. Sodickson, PHD,‡ Scott D. Flamm, MD,§ Peter Buser, MD, FESC,‖ Stefan Neubauer, MD, FRCP, FACC,# for the 2007 Scientific Program Committee of the Society for Cardiovascular Magnetic Resonance

Calgary, Alberta, Canada; Charlottesville, Virginia; New York, New York; Cleveland, Ohio; and Oxford, United Kingdom

The Society for Cardiovascular Magnetic Resonance (SCMR) held its 2007 meeting from February 2 to February 4 in Rome, Italy. As has been traditional when it is held in Europe, the meeting was held jointly with the Working Group for Cardiovascular Magnetic Resonance (CMR) of the European Society of Cardiology with an expanded program committee to reflect the input of both societies. Reflecting the growing interest in CMR, 885 (an increase of over 10% increase from 2006) clinicians and investigators, technologists, and nurses attended this year's meeting. The program itself was larger than ever and featured 9 clinical sessions, 8 "meet the expert" discussions, 5 basic magnetic resonance science sessions, 4 case discussions, 2 congenital sessions, 2 political sessions, and the annual trainee session. Among a record number of 546 submitted abstracts, the review panel selected 87 abstracts for oral presentations; 13 as moderated posters, and 341 as posters. Additionally, 139 invited speakers provided state-of-the-art review talks, viewpoints, and new data. Among this year's areas of interest were CMR of acute myocardial infarction, stem cell tracking, nonischemic cardiomyopathies, molecular imaging, the comparative utility of CMR and cardiac computerized tomography, and interventional CMR.

From the *Stephenson CMR Centre at the Libin Cardiovascular Institute of Alberta, University of Calgary, Calgary, Alberta, Canada; †University of Virginia Health System, Charlottesville, Virginia; ‡New York University, New York, New York; §Cleveland Clinic Foundation, Cleveland, Ohio; ‖University Hospital, Basel, Switzerland; and #Oxford University, Oxford, United Kingdom. Members of the 2007 Program Committee are listed in the Appendix.

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Workshops

In addition to the introductory physicians' CMR course (Chair, Dr. Peter Buser, University Hospital, Basel), a preconference workshop was offered on basic and experimental research in CMR. This session was endorsed by the International Society for Magnetic Resonance in Medicine, was chaired by Dr. Daniel Sodickson (New York University, New York, New York), and addressed the growing interest in cardiovascular-specific advances of magnetic resonance imaging technologies. Discussions focused on coil technology, rapid imaging, and metabolic imaging. Special attention was given to high accelerations afforded by a 128-element detector array (1). Dr. Roderic Pettigrew (National Institute of Biomedical Imaging and Bioengineering, Bethesda, Maryland) placed CMR in the context of various new or newly combined imaging modalities aimed at cellular and molecular imaging. The workshop concluded with recognition of the need for intertwined developments in engineering, chemistry, and biology to catalyze the cardiac imaging of the future.

A 3-day technologists' meeting (Chair, Mary Watkins, Washington University, St. Louis, Missouri) was held parallel to the main meeting.

Clinical CMR

CMR tissue characterization: myocardial infarction. The opening plenary session of the meeting was aimed at an area for which CMR is particularly well suited: the assessment of myocardial infarction (MI) and its therapy. Car-

Abbreviations and Acronyms

CMR = cardiovascular magnetic resonance
MI = myocardial infarction
MRA = magnetic resonance angiography
MRS = magnetic resonance spectroscopy

diovascular magnetic resonance is now viewed as a gold standard for assessment of infarct size and microvascular obstruction after acute MI and is increasingly used in clinical trials involving acute MI patients and imaging end points.

After an introductory lecture by Dr. Volker Schächinger (J. W. Goethe University, Frankfurt, Germany), Dr. Dara Kraitchman (Johns Hopkins University, Baltimore, Maryland) underscored the ability of CMR to track stem cells in the myocardium with various techniques. Dr. Andrew Arai (National Heart, Lung, and Blood Institute, Bethesda, Maryland) reviewed unique applications of CMR in acute MI, specifically T2-weighted imaging of the area at risk. This development has now been validated in animal models and is being studied in human patients. Dr. Christopher Kramer (University of Virginia, Charlottesville, Virginia) discussed the important prognostic potential of microvascular obstruction in acute MI patients identified as areas of low signal on both early and late gadolinium-enhanced images.

Tissue characterization: nonischemic myocardial disease. Two sessions addressed myocarditis and other nonischemic cardiomyopathies. The clinical impact of subclinical myocardial disease detected by CMR was debated. Several clinical examples were discussed, including patients with atypical symptoms but nonischemic patterns of myocardial late enhancement, later proved by biopsy to have myocarditis. Speakers emphasized the increasing body of evidence for the prognostic value of irreversible myocardial injury as defined by "late-enhancement" CMR in nonischemic myocardial disease. Excellent prognostic value had already been shown in patients with otherwise unrecognized MI (2). Additional provocative findings included that of late enhancement in subjects with aortic stenosis (62%) and arterial hypertension (45%), despite similar magnitudes of left ventricular hypertrophy and the absence of coronary artery disease (3). Late enhancement has also been visualized in the atria in cardiac amyloidosis (4). A study in 42 patients with arrhythmogenic right ventricular dysplasia interestingly showed that fat infiltration is rarely the only CMR imaging abnormality, with regional right ventricular systolic dysfunction being more sensitive and specific (5). Dr. Alessia Pepe (Institute of Clinical Physiology, Pisa, Italy) and colleagues reported on a multicenter CMR study of myocardial iron overload and fibrosis in patients with thalassemia intermedia (6). Twenty-three percent of these patients had evidence for mostly heterogeneous myocardial iron overload despite normal global T2* values, and 32% showed myocardial fibrosis.

CMR of myocardial ischemia. The recent accumulation of outcome data for CMR using dobutamine stress, first-pass perfusion, and late enhancement was underscored by a study from Dr. Erica Dall'Armellina (Wake Forest University, Winston-Salem, North Carolina), who showed that dobutamine-stress CMR predicted major cardiac events in the following 2 to 3 years in patients with reduced ejection fraction and poor echocardiographic windows (7).

CMR in acute heart disease. Several speakers reported on their initial experience in applying CMR to risk-stratifying patients with chest pain in the emergency room, including dedicated T2-weighted images and adenosine stress perfusion. Dr. Oliver Strohm (University of Calgary, Alberta, Canada) presented an estimate that in patients with acute chest pain but absence of elevated troponin or ST-segment elevation, CMR may not only be helpful in establishing the diagnosis, but may also be more cost-effective than other imaging-based approaches.

CMR protocol optimization. A session about clinical protocol optimization focused on practical issues for CMR clinicians. Dr. Sven Plein (University of Leeds, Leeds, United Kingdom) emphasized the feasibility of performing a comprehensive 1-h "core" CMR exam including cine functional imaging, stress and rest perfusion imaging, whole-heart coronary artery imaging, and late enhancement. Other presentations highlighted real-time cine methods and 4-dimensional velocity mapping of the thoracic aorta. The advantages of a new "whole-heart" coronary artery imaging approach, akin to 3-dimensional (3D) computerized tomographic angiography were emphasized.

Multidetector CT and CMR of coronary arteries. This session, cosponsored by the Society of Cardiovascular Computed Tomography reported on the current feasibility, safety, and diagnostic accuracy of both techniques to assess coronary artery stenoses. A constructive discussion pointed out that, whereas multidetector CT currently offers a higher diagnostic accuracy in the assessment of coronary artery stenoses, CMR has advantages over CT in determining their hemodynamic relevance and related viability, without exposing the patient to ionizing radiation or iodinated contrast.

CMR at 3-T. Several centers reported 3-T stress perfusion imaging to be superior to that at 1.5-T for the detection of coronary artery stenosis. Dr. Rolf Gebker (German Heart Institute, Berlin, Germany) presented a study of 14 patients demonstrating an overall diagnostic accuracy of 84% (8). Dr. Adrian Cheng (Oxford University, Oxford, United Kingdom) reported an accuracy of 90% in 61 patients, compared with 82% when using 1.5-T in the same group (9).

Vascular CMR. Among the technical innovations and improvements in vascular CMR, new approaches to contrast-enhanced magnetic resonance angiography (MRA) were presented, including 3D contrast-enhanced MRA with time-resolved 3D data sets acquired in a second each and continuous-table-motion MRA techniques for imaging the entire pelvic and peripheral arterial tree.

Award session for clinical CMR research. The "Young Investigator Award for Clinical CMR Research" session

was dedicated to the memory of Dr. Walter Rogers, one of the founders of the SCMR. His many contributions to the field were highlighted in a short eulogy by Dr. Robert Biederman (Allegheny General Hospital, Pittsburgh, Pennsylvania) presented before the abstract presentations. Featuring topics such as rapid imaging and post-transplant imaging, the presentations highlighted creative applications of CMR in a practical fashion. Dr. Hamid Sattar (Brigham and Women's Hospital, Boston, Massachusetts) received the award for his work on CMR in diabetic patients. His study showed not only that CMR visualized previously undetected infarcts, but also that the extent of infarct scar predicted outcome (10).

Dr. Juan Santos (Stanford University, Stanford, California) won the Poster Prize for his presentation on rapid late-enhancement imaging with real-time inversion time adjustments (11). The second poster prize went to Federico Mordini for his work on fully quantitative perfusion image analysis (12).

Other topics presented included methods to shorten postprocessing and improve reproducibility of methods for perfusion analysis and diastolic and systolic functional analysis and an imaging algorithm for CMR in the setting of patients presenting with chest pain syndromes (13). Lucia Ma's (University of Calgary, Alberta, Canada) moderated poster presentation on the improved interobserver variability of short-axis left ventricular volumetry by long-axis cross-references sparked debate during the session, particularly regarding the standard methodology used for defining cardiac phases and slice localization (14).

Experimental and Basic CMR

Parallel imaging. Several speakers emphasized that high levels of image acceleration are now possible with multiple-receiver magnetic resonance systems and multiple-element optimized radiofrequency (RF) coil arrays. The latter are considered a key enabling factor for high accelerations, together with prevailing trends toward the use of 32+ receiver channels and high-field imaging (e.g., 3-T and beyond). Speakers anticipated that single breath hold whole-heart cine CMR for rapid assessment of cardiac function will further improve patient comfort and slice registration. The attendees appreciated the combination of leading-edge technology development (RF coils, pulse sequences, image reconstruction) and clinically focused research and applications (function, perfusion, delayed enhancement, angiography).

Interventional CMR. Cardiovascular applications of interventional CMR continue to gain strength as evidenced by a session devoted to new advances. Dr. Timm Dickfield (University of Maryland, Baltimore, Maryland) reported on the accumulating evidence regarding the clinical potential of CMR-guided radiofrequency ablation. The anatomic detail of the pulmonary veins from MRA can be used as a road map to guide conventional X-ray ablation procedures. New data on wireless magnetic resonance–active devices with high signal-to-noise properties were presented by Dr. Harald Quick (University Hospital, Essen, Germany). Dr. Titus Kühne (German Heart Institute, Berlin, Germany) highlighted the importance of using CMR instead of multidetector CT in pediatric interventions so as to reduce ionizing radiation exposure. Dr. Ergin Atalar (Bilkent University, Ankara, Turkey) underscored that all magnetic resonance devices are safe if they are used within preset device-specific guidelines along with careful monitoring and poststudy testing.

Ultrahigh-field CMR. This broad-ranging session reflected the marked expansion in this area that has accompanied both the use of small-animal models in cardiovascular research and the application of those models in pursuit of molecular and cellular CMR imaging. Speakers reviewed data on high-field applications for murine myocardial perfusion (Dr. David Sosnovik, Massachusetts General Hospital, Boston, Massachusetts), vulnerable plaque imaging with perfluorocarbon nanoparticles (Dr. Tillmann Cyrus, Washington University, St. Louis, Missouri), and using ligand-conjugated iron oxide microparticles for visualizing vascular inflammation and platelet thrombosis (Dr. Robin Choudhury, John Radcliffe Hospital, Oxford, United Kingdom).

New coil designs. Three trends in modern coil design became obvious: 1) the use of an increasing number of coil array elements for parallel detection; 2) the move toward progressively higher magnetic field strength; and 3) the rising interest in parallel transmission with multiple independent transmitter coils. Dr. Thoralf Niendorf (University of Aachen, Aachen, Germany) highlighted synergies between high-field CMR and highly parallel imaging with multiple-element detector arrays. The potential use of parallel transmission systems for selective cardiac excitations or for the improvement of image homogeneity at high magnetic field strength was highlighted. Dr. Elliot McVeigh (National Institutes of Health, Bethesda, Maryland) called for improvements to the ergonomic design of coils, arguing that the trends described earlier in the session should spur the development of wireless miniaturized flexible coil arrays that can conform easily to the surface of the body or that can be incorporated into interventional devices.

Molecular CMR. This session compared molecular imaging of cardiovascular disease with CMR and other techniques, including optical imaging, ultrasound, radiotracers, and magnetic resonance spectroscopy. Hybrid approaches combining optical imaging with CMR may allow for nanomolar-range sensitivity, multispectral capabilities, and high-throughput screening. These attributes complement the high resolution, excellent contrast, and functional imaging properties of CMR.

CMR spectroscopy. Two studies addressed the effect of fasting on myocardial triglyceride content and cardiac function. Both used ^{1}H magnetic resonance spectroscopy (MRS) to show that caloric restriction leads to a significant increase of septal myocardial triglyceride content, correlating with diastolic

dysfunction and increases in plasma free fatty acids (15,16). Researchers from Tohoku University in Japan used ^{31}P-MRS to show that B-type natriuretic peptide (BNP) did not correlate significantly with the myocardial phosphocreatine/adenosine triphosphate ratio, whereas log BNP did (17). A promising tool for in vivo studies of atherosclerosis using hyperpolarization was a new lipid-targeted atherosclerotic plaque-binding molecule, tetrafluoropropylacrylate, which rapidly binds to lipid membranes (18).

Rodent CMR. There is increasing application of CMR in small animals. The main topics presented included targeted imaging in atherosclerosis models, molecular imaging in cell therapies/transplant models, and general technical developments. Researchers from the Mount Sinai School of Medicine, New York, reported on the application of gadolinium-based micelles for plaque characterization, conjugated to macrophage-specific scavenger receptor antibodies (19), oxidation-specific epitopes (20), or high-density lipoproteins (21). Dr. Martina McAteer (University of Oxford, Oxford, United Kingdom) used superparamagnetic microparticle iron oxide-based contrast agents to target endothelial adhesion molecules in atherosclerosis or activated platelets in a mouse model of vascular injury (22). Iron oxide-based CMR contrast markers may play an important role also in monitoring stem cell therapy after myocardial infarction (23) or for 3D cardiac tissue engineering (24). Technical developments in small-animal CMR included the application of a coil array and parallel imaging to accelerate CMR at ultrahigh magnetic fields (25).

Experimental vascular CMR. Among the highlights in vascular CMR were a novel coronary vein imaging sequence with improved contrast based on magnetization transfer (26), a dark-blood coronary vessel wall sequence used to show increased coronary plaque burden in diabetic patients with nephropathy as opposed to those without (27), and a novel fibrin-targeted contrast agent, suitable for single-photon emission computerized tomography as well as ^{1}H- and ^{19}F-CMR (28).

Award session for experimental CMR research. The "2007 Young Investigator Award for Experimental CMR Research" session was held in honor of Dr. Frank Wiesmann, MD, a young German researcher who had performed landmark studies in murine CMR models and sadly passed away in 2006. The prize was given to Dr. Emily Waters (Washington University, St. Louis, Missouri) for her work on ^{19}F-MRS of atherosclerosis-associated inflammatory angiogenesis in aortic valves of rabbits (29).

Congenital CMR

Recognizing increasing clinical applications and interest, 3 plenary sessions were devoted to congenital CMR. A special session covered the role of CMR for imaging the right ventricle (RV) for morphology and quantification of global and regional function. Dr. Tal Geva (Children's Hospital, Boston, Massachusetts) emphasized the role of ventriculo-arterial coupling, RV/left ventricle interaction, and RV myocardial fiber orientation as important variables of cardiac performance. The important role of CMR in quantitatively assessing the systemic RV in dual-chamber circulations was addressed by Dr. David Patton (University of Calgary, Alberta, Canada) and in single-ventricle physiology by Dr. Mark Fogel (Children's Hospital, Philadelphia, Pennsylvania).

Data on coronary artery imaging at 1.5- and 3-T using a free-breathing navigator-gated 3D whole-heart approach in children and adults with an assortment of congenital anomalies were presented (30,31). Several abstracts centered around the assessment of atrial left-to-right shunts, reporting new data on CMR for the detection and quantification of sinus venosus atrial septal defects and partial anomalous pulmonary venous connections in the patient with RV enlargement of unknown cause (32) and on CMR guidance of cardiac catheterization to assess pulmonary vascular resistance in left-to-right shunt lesions (33).

Young Investigator Award for CMR in Congenital Heart Disease. The "2007 Young Investigator Award for CMR in Congenital Heart Disease" winner was Dr. Danielle Robbers-Visser (Erasmus University, Rotterdam, the Netherlands), for her work on the abnormal response of single-ventricle patients to dobutamine-stress CMR in patients after a Fontan procedure (34).

Best Technologist Abstract

Mercedes Pereyra (St. Luke's Hospital, Houston, Texas) won the prize of the best technologist abstract for her work on evaluation of single-shot CMR for assessing myocardial viability (35).

Conclusions

Highlights of the 2007 10th Annual Sessions of the SCMR and 6th Annual Meeting of the Working Group for Cardiovascular Magnetic Resonance of the European Society of Cardiology were numerous reports on improved CMR techniques, optimized protocols, and an increasing body of evidence for its prognostic value. Tissue characterization by CMR proves to have a unique potential compared with other advanced imaging modalities. Technical advances in coil design and parallel imaging as well as convincing data on 3-T CMR open new fields for research and clinical applications. Cardiovascular magnetic resonance for interventions and for metabolic imaging is emerging.

The 2008 Annual Sessions will be held from January 31 to February 3, 2008, in Los Angeles, California.

Additional details on previous and future meetings can be found on the SCMR website (www.scmr.org).

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Reprint requests and correspondence: Dr. Matthias G. Friedrich, Stephenson CMR Centre at the Libin Cardiovascular Institute of Alberta, University of Calgary, SSB–Foothills Medical Center, 1403 29th Street NW, Calgary, Alberta T2N 2T9, Canada. E-mail: matthias.friedrich@ucalgary.ca.

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APPENDIX

For a list of the 2007 Scientific Program Committee of the SCMR, please see the online version of this article.