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COMPARISONS WITH OTHER IMAGING TECHNOLOGIES

Could Cardiac Magnetic Resonance Imaging Replace Cardiac Ultrasound? Challenges from the Echocardiography Laboratory

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Echocardiography is, at present, the most widely used noninvasive technique for dynamic imaging of the heart. Cardiac magnetic resonance imaging (CMRI) offers superb image resolution and information on blood flow, as well as cardiac anatomy. It is free from problems of poor anatomical windows, which make echocardiography difficult in some patients, while technical improvements have reduced the need for extended breath-holding. The relative roles of echocardiography and CMRI in clinical cardiac care are evolving. Pohost and Biederman (1) have described CMRI as "the cornerstone of cardiac imaging in the next millennium."

Could CMRI replace echocardiography? If CMRI is to serve all cardiac imaging needs, it is useful to review the reasons clinicians request imaging studies. We reviewed the experience of our busy adult echocardiography laboratory at the University of Iowa. During the 5-month period—January through May 2000—the echocardiography lab at the University of Iowa performed 2080 transthoracic and 163 transesophageal echocardiograms (dobutamine and exercise echocardiograms are not included in these totals). We identified transthoracic and transesophageal echocardiograms performed for the following reasons: to search for a cardiac source of cerebral embolism, including a patent foramen ovale (typically requested by the Neurology Service), to search for valvular vegetations and/or myocardial abscess (usually in-patients on Cardiology or Internal Medicine services), to rule out a left atrial appendage thrombus in patients with atrial fibrillation or atrial flutter, in anticipation of electrical cardioversion (so-called "TEE-guided cardioversion," which obviates the need for prolonged precardioversion anticoagulation, usually requested by the Cardiology Service), and to rule out aortic dissection or aortic trauma (usually requested by the Thoracic Surgery or Trauma services). In addition, we identified patients whose physicians requested examinations be performed as a portable (bedside) exam, either because the patient was considered critically ill, hemodynamically or rhythmically unstable, or because the patient was being treated with a ventilator, intra-aortic balloon counterpulsation, etc., making movement difficult.

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Table 1

Indications for Echocardiography—% of Total Echos Ordered Jan 1–May 30, 2000

	Cardiac Source of Thromboembolism (%)	Infective Endocarditis and/or Myocardial Abscess (%)	Aortic Dissection or Trauma (%)	Portable (Bedside) Exams (%)	Other (%)
TTE	9	34	1	11	45
TEE	44	23	6	23	4

TTE = Transthoracic echocardiograms (Total 2080).
TEE = Transesophageal echocardiograms (Total 163).

We focused on conditions that a priori might be expected to pose a challenge to CMRI—small, mobile abnormalities and/or critically ill patients requiring emergency and/or portable examinations. The results of this review are shown in Table 1. As the table indicates, substantial percentages of the echocardiogram requests (43% of TTEs and 67% of TEEs) involve the identification of small, highly mobile abnormalities, such as thrombi or vegetations. Bedside examinations (11% of TEEs and 23% of TEEs) were required by many seriously ill patients who could be moved to a CMRI unit only with difficulty and/or danger. Of the remaining echocardiogram requests, 45% of the TTE exams involved indications such as LV function for which MRI is well suited, but only 4% of our TEE requests requested such information and did not require bedside/portable exams.

The ability of CMRI to demonstrate ventricular and atrial chamber size, mass and global, and regional function make it an extremely attractive tool for clinical use. The promise of myocardial perfusion and noninvasive coronary angiography adds to the excitement of this new technology. A challenge for users of CMRI is to show that the technique can perform as well as echocardiography in the identification of small, often mobile lesions (thrombi, vegetations), and the demonstration of conditions that identify patients at high risk for systemic thromboembolism, including the presence of spontaneous ultrasound contrast or "smoke" and patent foramen ovale with right to left shunting (shown on echo by intravenous agitated saline ("bubble") injections).

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A major advantage of echocardiography is its relatively small size, availability, and ease of examination. To perform equivalently, CMRI must be available to examine critically ill patients on very short notice (the American Society of Echocardiography recommends that a stat examination be performed as soon as the personnel and equipment can be assembled, whether during a working day or not; routine studies should be preempted when necessary). Portability is another echo advantage; to match it, portable CMRI units would have to be developed for urgent examinations at the bedside or in an intensive care unit, emergency room, or operating room. Especially outside normal working hours, it would be desirable that an emergency CMRI examination require a minimum of personnel to both perform and interpret—ideally, one physician and no technologist.

These requirements pose a challenge for CMRI. Echocardiography and CMRI both have clinical strengths and limitations, and, for the near future, both will be heavily utilized in cardiac imaging. Technological developments in accuracy, portability and ease of use will play a major role in determining the relative use of the two techniques in the future.

REFERENCE

1. Pohost, G.M.; Biederman, R.W.W. The Role of Cardiac MRI Stress Testing: "Make a Better Mouse Trap." Circulation **1999**, *100*, 1676–1679.