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Comprehensive Dobutamine Stress CMR Versus Echocardiography in LBBB and Suspected Coronary Artery Disease

Ify Mordi, MBChB,* Tony Stanton, PhD,† David Carrick, MBChB,* John McClure, PhD,* Keith Oldroyd, MD,‡ Colin Berry, PhD,*‡ Nikolaos Tzemos, MD*‡

Glasgow and Clydebank, United Kingdom; and Brisbane, Australia

OBJECTIVES This study aimed to compare dobutamine stress cardiac magnetic resonance (DSCMR) with dobutamine stress echocardiography (DSE) in patients with left bundle branch block (LBBB) and suspected coronary artery disease (CAD).

BACKGROUND Noninvasive diagnosis of CAD in patients with pre-existent LBBB is difficult because single-photon emission computed tomography and stress echocardiography both have limitations. We hypothesized that a comprehensive DSCMR examination including cine, perfusion, and late gadolinium enhancement imaging would be more accurate than DSE, thus potentially reducing the number of unnecessary invasive coronary angiograms.

METHODS We prospectively evaluated 82 consecutive patients with LBBB referred to our cardiology clinic for investigation of suspected CAD. All 82 patients underwent DSE, DSCMR, and invasive quantitative coronary angiography within 14 days. We compared the diagnostic accuracy of DSE, CMR cine imaging, the additive value of first-pass perfusion, and late gadolinium enhancement. In the comprehensive examination, a positive result was adjudged as the presence of either subendocardial or transmural late gadolinium enhancement with or without inducible peri-infarct ischemia or an inducible perfusion defect corresponding to an inducible regional wall motion abnormality.

RESULTS CMR cine imaging (regional wall motion abnormalities) had higher specificity, negative predictive value, and overall diagnostic accuracy than did DSE (87.5% vs. 72.9%; 80.8% vs. 67.3%; and 80.4% vs. 72.0%, respectively), although sensitivity was the same (72.0%). The addition of first-pass stress perfusion and late gadolinium enhancement (scar) further improved diagnostic confidence (sensitivity 82.4%, specificity 95.8%, positive predictive value 93.3%, negative predictive value 88.5%, and diagnostic accuracy 90.2%).

CONCLUSIONS DSCMR is a safe procedure and has greater diagnostic accuracy than does DSE in assessing patients with suspected CAD and LBBB. A comprehensive examination with the addition of perfusion and late gadolinium enhancement to CMR cine imaging significantly boosted specificity and sensitivity, making DSCMR a reliable alternative to invasive quantitative coronary angiography in this group of patients. (J Am Coll Cardiol Img 2014;7:490–8) © 2014 by the American College of Cardiology Foundation

From the *British Heart Foundation Glasgow Cardiovascular Research Centre, Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, United Kingdom; †Cardiovascular Imaging Research Centre, School of Medicine, University of Queensland, Brisbane, Australia; and the ‡West of Scotland Regional Heart and Lung Centre, Golden Jubilee National Hospital, Clydebank, United Kingdom. Dr. Berry has received honoraria from St. Jude Medical and AstraZeneca. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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Left bundle branch block (LBBB) is a cardiac conduction abnormality that causes the left side of the heart to contract later than the right side does (1). The prevalence of LBBB increases with age, and coronary artery disease (CAD) is the most common cause, with a prevalence estimated at 30% to 52% (2,3). Perhaps because of this, patients with LBBB have been shown to have significantly increased cardiovascular mortality (4).

See page 499

Given this situation, initial investigation of incidental LBBB is often directed toward exclusion of CAD. The majority of these patients have intermediate probability for CAD, and most pathways for investigation of CAD in the intermediate probability group recommend noninvasive functional assessment such as exercise electrocardiography (ECG), single-photon emission computed tomography (SPECT), or stress echocardiography (5,6). Whereas these techniques are robust and well validated in the general population, in patients with LBBB, they have certain limitations (7–11). Cardiac magnetic resonance (CMR) has the ability to overcome some of the disadvantages of other noninvasive investigations; however, its utility and potential superiority in this setting has not yet been established.

We hypothesized that, in patients with LBBB and suspected CAD, a comprehensive dobutamine stress cardiac magnetic resonance (DSCMR) examination including wall motion analysis, perfusion, and late gadolinium enhancement (LGE) imaging would be more accurate in diagnosis of CAD than dobutamine stress echocardiography (DSE) would be when compared to the gold standard of invasive coronary angiography (ICA).

METHODS

Study population. We prospectively investigated 82 consecutive patients with LBBB who were referred to our clinic with suspected CAD over a period of 12 months. All patients underwent DSE, DSCMR, and ICA. All tests were performed within 14 ± 8 days by observers blinded to results of the others. The study protocol is summarized in Figure 1.

We included patients with LBBB and suspected CAD based on clinical judgment of the referring cardiologist. Patients were of intermediate probability of CAD as recommended by current clinical guidelines for investigation of suspected stable angina (5,11–13). The patients were all age ≥40 years and had typical features of angina (exertional chest pain or dyspnea) with 1 or more risk factors. We excluded patients who had a previous history of established CAD, those with renal impairment (estimated glomerular filtration rate <60 ml/min/1.73 m^2), metallic implants incompatible with CMR, uncontrolled arterial hypertension (baseline systolic blood pressure >190 mm Hg or diastolic blood pressure >100 mm Hg), atrial fibrillation with uncontrolled ventricular response, and prior adverse reaction to dobutamine. Antianginal medications, including oral beta-blockers, calcium-channel blockers, and nitrates, were not discontinued before DSCMR. For each examination (DSCMR, DSE, and ICA), analysis was performed by 2 observers blinded to the results of the other investigations. In case of any doubt, a third independent observer was used to adjudicate. All patients provided written informed consent to undergo DSCMR, DSE, and ICA, and the local ethics committee approved the study.

Dobutamine stress echocardiography. Two-dimensional transthoracic DSE was carried out in all patients using an IE33 scanner (Philips, Amsterdam, the Netherlands). All patients were pharmacologically stressed using dobutamine starting at a rate of 10 μg/kg/min and increased at 3-min intervals to 20, 30, and 40 μg/kg/min. If the target heart rate was not reached with dobutamine, intravenous boluses of atropine sulfate (0.25 to 0.5 mg aliquots up to a maximum total dose of 2 mg) were used at 30 or 40 μg/kg/min stages to augment the heart rate response. All studies were carried out with the patient in the left lateral position and with continuous ECG monitoring. Standard echocardiographic views were taken (parasternal long- and short-axis; apical 2-, 3-, 4-, and 5-chamber; and subcostal views). Images were acquired at rest and peak stress. Indications for terminating the dobutamine infusion were the following: the patient reaching target heart rate (i.e., 85% of predicted for age); occurrence of a new wall motion abnormality; development of significant symptoms (e.g., chest pain, dyspnea); or significant ECG changes such as arrhythmias. Intravenous contrast was used for all patients at both rest and stress.

Comprehensive DSCMR. DSCMR was performed with a 1.5-T system (Avanto Magnetom, Siemens, Erlangen, Germany). The order of sequences is summarized in Figure 2, and detailed CMR methods

ABBREVIATIONS AND ACRONYMS

AUC = area under the curve
CAD = coronary artery disease
CMR = cardiac magnetic resonance
DSCMR = dobutamine stress cardiac magnetic resonance
DSE = dobutamine stress echocardiography
ECG = electrocardiography
ICA = invasive coronary angiography
LBBB = left bundle branch block
LGE = late gadolinium enhancement
RWMA = regional wall motion abnormality
SPECT = single-photon emission computed tomography