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Cardiac Imaging

Prognostic Value of Stress Cardiac Magnetic Resonance Imaging in Patients With Known or Suspected Coronary Artery Disease

A Systematic Review and Meta-Analysis

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Objectives This study sought to perform a systematic review and meta-analysis to understand the role of stress cardiac magnetic resonance imaging (CMR) in assessing cardiovascular prognosis in patients with known or suspected coronary artery disease (CAD).

Background Although stress CMR is excellent for the diagnosis of obstructive CAD, the prognostic value of stress CMR has been less well described.

Methods PubMed, Cochrane CENTRAL, and metaRegister of Controlled Trials were searched for stress CMR studies with >6 months of prognostic data. Primary endpoints were cardiovascular death, myocardial infarction (MI), and a composite outcome of cardiovascular death or MI during follow-up. Summary effect estimates were generated with random-effects modeling, and annualized event rates were assessed.

Results Nineteen studies (14 vasodilator, 4 dobutamine, and 1 that used both) involved a total of 11,636 patients with a mean follow-up of 32 months. Patients had a mean age of 63 ± 12 years, 63% were male, and 26% had previous MI; mean left ventricular ejection fraction was 61 ± 12%; and late gadolinium enhancement was present in 29% and ischemia in 32%. Patients with ischemia had a higher incidence of MI (odds ratio [OR]: 7.7; $p < 0.0001$), cardiovascular death (OR: 7.0; $p < 0.0001$), and the combined endpoint (OR: 6.5; $p < 0.0001$) compared with those with a negative study. The combined outcome annualized events rates were 4.9% for a positive versus 0.8% for a negative stress CMR ($p < 0.0001$), 2.8% versus 0.3% for cardiovascular death ($p < 0.0001$), and 2.6% versus 0.4% for MI ($p < 0.0005$). The presence of late gadolinium enhancement was also significantly associated with a worse prognosis.

Conclusions A negative stress CMR study is associated with very low risk of cardiovascular death and MI. Stress CMR has excellent prognostic characteristics and may help guide risk stratification of patients with known or suspected CAD. (J Am Coll Cardiol 2013;62:826–38) © 2013 by the American College of Cardiology Foundation

Stress cardiac magnetic resonance imaging (CMR), either with vasodilator or dobutamine stress, has been shown to have excellent diagnostic accuracy for detection of significant coronary artery disease (CAD) (1–4). In addition, CMR provides valuable clinical data, including details on left ventricular function, the presence of late gadolinium enhancement (LGE), and whether there is structural or valvular heart disease. As a result, stress CMR is increasingly being used to assess chest pain in patients with known or suspected CAD. In addition, stress CMR may have a role after ST-segment elevation myocardial infarction (MI) to assess for residual ischemia due to coronary stenoses in noninfarct-related arteries (5,6). Furthermore, stress CMR can be used in patients with dilated cardiomyopathy to assess for ischemia and myocardial scar burden with LGE (7,8). Given the increasing health care costs associated with

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cardiovascular imaging, it is critical to validate the prognostic utility of stress CMR (9,10).

Over the past several years, multiple studies have been published regarding stress CMR assessment of prognosis. However, many of these studies are limited because they are small and single centered. Prognostic validation of stress CMR is critical because a negative stress CMR can be reassuring that the patient has a very low risk for major adverse cardiovascular events (MACE). Alternatively, patients with stress-induced wall motion abnormalities, abnormal perfusion, and/or LGE are at higher risk of MACE. In the current environment of escalating medical costs, the prognostic performance of stress CMR may also help justify its use compared with more commonly used stress modalities such as stress echocardiography and stress nuclear perfusion imaging. Given the multiple small and single-centered studies, we performed a systematic review and meta-analysis of studies reporting prognostic data from patients undergoing stress CMR to assess for myocardial ischemia in those with known or suspected CAD.

Abbreviations and Acronyms

AER = annualized event rate
CAD = coronary artery disease
CMR = cardiac magnetic resonance imaging
LGE = late gadolinium enhancement
MACE = major adverse cardiovascular event(s)
MI = myocardial infarction
OR = odds ratio

Methods

Eligibility criteria. We included any of the following: 1) study assessing for myocardial ischemia with stress CMR; 2) with ≥6 months of prognostic follow-up data, including cardiac death and/or MI; and 3) excluding populations composed of patients with cardiomyopathy or acute MI within the last 14 days.

Search strategy. To identify eligible studies for inclusion in the current systematic review and meta-analysis, 2 independent reviewers (M.J.L. and C.M.M.) systematically searched (October 2012) Cochrane CENTRAL, meta-Register of Controlled Trials, and PubMed for studies assessing prognosis in patients with known or suspected CAD after undergoing stress CMR. Key words used were "prognosis" OR "outcome" AND "stress magnetic resonance imaging" or "dobutamine magnetic resonance imaging" or "adenosine magnetic resonance imaging." In addition, we consulted experts, reviewed citations from eligible studies, and explored "see related articles" for key publications in PubMed. The search was limited to studies published in peer-reviewed journals and thus excludes trials presented in abstract form only. We restricted the review to studies that enrolled adults only. No language restriction was applied. The current systematic review and meta-analysis was performed in accordance with guidelines of the MOOSE (Meta-analysis of Observational Studies in Epidemiology) and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) groups (11,12).

Study selection. Two investigators (M.J.L. and C.M.M.) independently and in duplicate scanned all abstracts and obtained full-text reports of articles that indicated or suggested eligibility. After obtaining full reports, the same reviewers independently assessed eligibility from the full-text articles, with divergences resolved after consensus. Study quality was evaluated by the Newcastle-Ottawa Quality Assessment Scale for Cohort Studies (13), in which the quality of the selected trials was determined on the basis of selection of the study groups (0 to 4 points), comparability of the study groups (0 to 2 points), and ascertainment of the outcome of interest (0 to 3 points).

Data collection. Data abstraction and study appraisal were performed by the same 2 aforementioned investigators. Clinical outcomes of interest were cardiovascular death, MI, or the composite outcome of cardiovascular death or MI during follow-up. Clinical outcomes data were directly abstracted when reported. Unadjusted hazard ratios were used to determine the number of events if not provided for each group, and

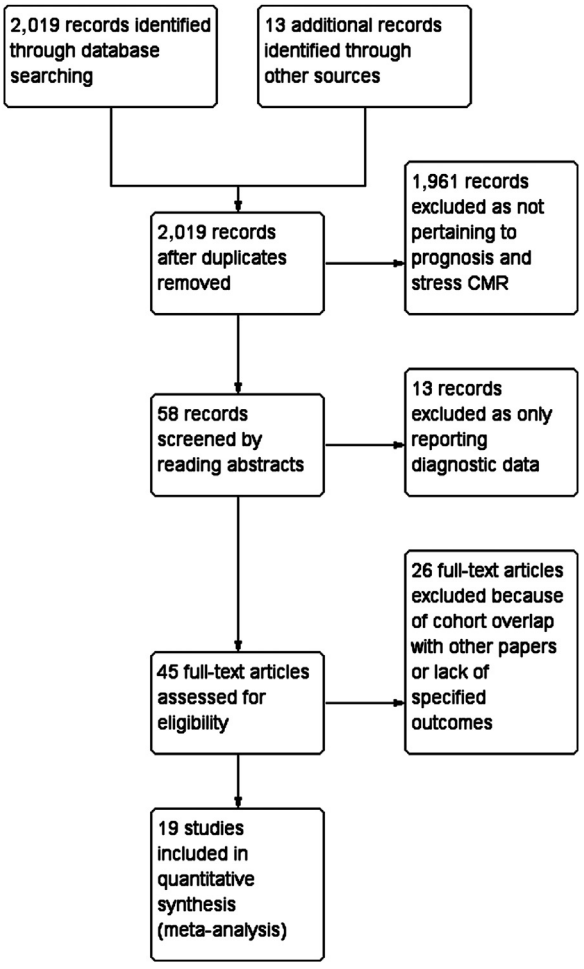

Figure 1 Flow Diagram of the Review Process

CMR = cardiac magnetic resonance imaging.