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Combined stress myocardial perfusion and late gadolinium enhancement imaging by cardiac magnetic resonance provides robust prognostic data to cardiac events

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Introduction

Cardiac Magnetic Resonance (CMR) can obtain accurate information regarding ventricular function, viability, and can also detect evidence of ischemia by myocardial perfusion imaging. While each of these components may prognosticate cardiac patients from a different pathophysiologic perspective, we seek to determine the relative strengths of association of each of these components of CMR with hard cardiac events.

Purpose

We further hypothesize that evidence of myocardial ischemia can provide incremental prognostic information beyond LVEF and presence of myocardial scar.

Methods

We performed stress CMR on 473 patients (196 females, mean age 56 ± 12 years) with an intermediate pre-test likelihood of CAD referred for assessment of myocardial ischemia. Rest and vasodilator stress CMR myocardial perfusion were performed using a 0.07-0.1 mmol/Kg bolus infusion of gadolinium, followed by cine function imaging and late gadolinium enhancement (LGE) 10 minutes after a cumulative dose of 0.15-0.2 mmol/Kg of gadolinium. CMR myocardial perfusion images were interpreted for reversible myocardial perfusion defect (RevPD) using the 16-segment nomenclature and LGE was graded separately. The readers were blinded to all clinical outcomes.

Results

At a median follow-up of 26.4 months (range from 3 months to 7 years), 39 major adverse cardiovascular events (MACE) (8%) had occurred (27 cardiac deaths and 12 acute myocardial infarctions). A CMR study negative for RevPD and LGE predicted a low negative annual event rate for MACE (1.3%) and cardiac deaths (0.9%). By uni-

Table 1: Univariable association with MACE in the study group

	MACE (n = 39)		
Variables	**HR**	**HR 95% CI**	**P**
Age, years	1.06	1.03-1.09	<0.001
Female	1.01	0.64-1.09	0.986
Hypertension	3.73	1.69-8.23	0.33
Diabetes	2.6	1.38-4.93	0.003
Hx MI	2.69	1.38-4.93	0.002
Hx PCI	3.25	1.70-6.23	<0.001
LVEF, per 10%	0.95	0.93-0.97	<0.001
LC Mass Index	1.03	1.01-1.04	<0.001
LVEDVi	1.02	1.01-1.02	<0.001
LVESVi	1.01	1.01-1.03	<0.001
RWMA	5.08	2.63-9.8	<0.001
Stress perfusion defect	6.59	3.19-13.61	<0.001
RevPD	6.17	3.17-12.28	<0.001
LGE	2.67	2.63-9.8	<0.001
RevPF/LGE	5.13	2.5-10.54	<0.001

Table 2: Best final model for MACE by stepwise forward selection

Variable	Hazard Ratio	P-value	Chi-square
Age	1.03	0.051	3.80
Hx PCI	2.51	0.013	6.12
LVESVi	1.02	0.001	9.9
RWMA	3.62	0.016	5.71
Presence of LGE	0.21	0.007	7.28
RevPD	4.67	< 0.001	11.09

LGE = late gadolinium enhancement; Hx = history; LVEF = left ventricular ejection fraction; LVESVi = left ventricular end-sistolic volume index, LVEDVi = left ventricular end-diastoliv volume index; RWMA = resting wall motion abnormality and PCI = percutaneous coronary intervention.

variable analysis, the presence of RevPD and LGE portended to >6-fold and >2.67-fold increase in MACE, respectively ($P < 0.001$, $P = 0.003$) (table 1). In addition, RevPD and LGE portended to a >4-fold increase and >3-fold to increase in cardiac death ($P < 0.001$, $P = 0.006$), respectively. Adjusting for age, LVEF and LGE, RevPD maintains a strong adjusted association with MACE (adjusted HR 4.2 $P < 0.001$). By stepwise forward selection strategy (table 2), considering all available variables, RevPD persisted as a strong predictor of MACE in the best final model.

Conclusion

Reversible myocardial perfusion as evidence of myocardial ischemia provides strong and incremental prognostic information to patients presented with an intermediate likelihood of CAD. In addition, combining myocardial perfusion imaging and late gadolinium enhancement imaging, a negative CMR study portends an excellent (99%) negative event rate for cardiac death.