Comprehensive Quantitation of Myocardial Infarct Size by Cardiac Magnetic Resonance Imaging Predicts Future Cardiovascular Events in Ischemic Cardiomyopathy Patients Considered for Revascularization

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Background There is considerable risk in revascularization therapy for patients with ischemic cardiomyopathy (ICM). Reliable prognosis of these patients will enable a precise therapeutic decision-making. Cardiac MRI (CMRI) can provide quantitative data of myocardial scar tissue. We examined whether we could use quantitative data generated from CMRI to predict cardiovascular events (CVE) in ICM patients undergoing percutaneous (percutaneus coronary intervention (PCI)) or surgical (coronary arterial bypass grafting (CABG)) revascularization.
Methods We prospectively studied 81 ICM patients with CMRI. Thirty patients (mean left ventricular end diastolic volume (LVEDV): 239 ± 99 ml, mean left ventricular end systolic volume (LVESV): 184 ± 97 ml, mean left ventricular ejection fraction (LVEF): 27 ± 13%) underwent revascularization therapy and were followed for development of CVE: ventricular arrhythmia (VA) including ventricular tachycardia, ventricular fibrillation or implantable cardiac defibrillator firing; worsening congestive heart failure; hospitalization; myocardial infarction (MI); repeat revascularization; syncope; and cardiovascular death. The short-axis delayed enhancement images (DE) by CMRI were evaluated for the presence of scar and traced manually to measure total scar volume. An infarct region was defined as an area of DE, with a higher signal intensity (≥2 SD) compare to remote region in the same slice. Myocardial and scar volume were calculated as (area myocardium or area scar × slice thickness of 10 mm). The scar percentage of myocardial volume was also expressed as percentage of the total myocardial volume (volume scar / volume myocardium × 100). In order to analyze the transmurality of myocardial scar, we analyzed DE images using the 72-segment model in which the left ventricle was divided into 12 circumferential segments in six short-axis views. The transmural extent of DE was measured in each segment: 1 to 75% (non-transmural) and 76 to 100% (transmural).
Results Of the 30 revascularization patients, 9 (30%) underwent PCI and 21 (70%) underwent CABG. Fifteen patients (50%) had CVE (mean follow-up: 18.3 ± 16.6 months). Patients who developed CVE had larger scar volume (19.9 ± 12.1 cm^3 vs. 10.8 ± 11.9 cm^3, $p = 0.023$) and scar percentage of the myocardium (12.7 ± 7.7% vs. 6.3 ± 7.3%, $p = 0.013$) than those who did not develop CVE. There were no significant differences in LVEDV, LVESV and LVEF between the patients with and without CVE (231 ± 96 ml vs. 247 ± 104 ml, 176 ± 91 ml vs. 192 ± 106 ml, and 28 ± 11% vs. 26 ± 15%, respectively). Patients with scar volume greater than 10cm^3 or scar percentage greater than 10% had more CVE ($p = 0.0281$). In addition, patients who had CVE had larger proportion of non-transmural than patients who did not have CVE (21.5 ± 15.5% vs. 9.7 ± 7.3%, $p = 0.010$). There was no significant difference in the occurrence of CVE between PCI and CABG groups.
Conclusion Comprehensive quantitation of myocardial scar including volume, percentage and transmurality by CMRI are superior to LVEDV, LVESV, and LVEF in prognosticating future likelihood of the development of CVE. These quantitative determinants can predict the occurrence of CVE in ICM patients considered for revascularization. In ICM patients with infarct scar volume > 10 cm^3, scar percentage > 10%, and presence of non-trasmural scar, revascularization therapy may not be suitable therapy.

Table. Predictors of Cardiovascular Events

	CVE (+)	CVE(-)	*p*
Scar volume (cm^3)	19.9 ± 12.1	10.8 ± 11.9	0.023
Scar % of myocardium scar (%)	12.7 ± 7.7	6.3 ± 7.3	0.013
LVEF (%)	28 ± 11	26 ± 15	0.388
LVEDV (%)	231 ± 96	247 ± 104	0.335
LVESV (%)	176 ± 91	192 ± 106	0.328
Non-transmural MI (1-75% scar of myocardium)	21.5 ± 15.5	9.7 ± 7.3	0.010

Values are expressed as a mean ± SD.
CVE = cardiovascular events; LVEF = left ventricular ejection fraction; LVEDV = left ventricular end diastolic volume; LVESV = left ventricular end systolic volume; MI = myocardial infarction.