Original Article

Retrospective, observational analysis of cardiac function associated with global preoperative myocardial scar in patients with ischemic cardiomyopathy after coronary artery bypass grafting

Wei Fu[1], Yang Zhao[1], Kui Zhang[1], Qinyi Dai[2], Jumatay Biekan[3], Jubing Zheng[1], Ran Dong[1], Junsheng Mu[1]

[1]Department of Cardiac Surgery, Beijing Anzhen Hospital, Capital Medical University, Beijing, China; [2]Department of Radiology, Beijing Anzhen Hospital, Capital Medical University, Beijing, China; [3]Circle Cardiovascular Imaging, Calgary, AB, Canada

Contributions: (I) Conception and design: R Dong, J Mu, Y Zhao, W Fu; (II) Administrative support: J Mu, R Dong; (III) Provision of study materials or patients: Y Zhao, K Zhang, Q Dai, J Biekan, J Zheng, R Dong, J Mu; (IV) Collection and assembly of data: W Fu, Y Zhao, K Zhang; (V) Data analysis and interpretation: W Fu, Y Zhao, K Zhang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Ran Dong; Junsheng Mu. Department of Cardiac Surgery, Beijing Anzhen Hospital, Capital Medical University, 2 Anzhen Road, Chaoyang District, Beijing 100029, China. Email: dongran6618@hotmail.com; wesleymu@hotmail.com.

Background: Drawing on accumulated patient data from a hospital database, the goal of this retrospective study was to analyze cardiac function associated with global preoperative myocardial scarring assessed by cardiac magnetic resonance with late gadolinium enhancement (CMR-LGE) in patients with ischemic cardiomyopathy (ICM) after coronary artery bypass grafting (CABG).

Methods: A total of 57 patients diagnosed with ICM who underwent isolated CABG at Beijing Anzhen Hospital between September 2017 and September 2019 were enrolled in this retrospective study. All these patients underwent a preoperative CMR-LGE examination. Based on postoperative echocardiography results at 6 months, cases were divided into the following 2 groups: improved cardiac function [a difference of left ventricular ejection fraction (LVEF) greater than or equal to 5%] and unimproved cardiac function. The factors contributing to these patients' unimproved cardiac function were investigated.

Results: At 6 months after surgery, 64.9% (37/57) of cases had improved cardiac function, and 35.1% (20/57) had no improvement. There was no statistical difference between the 2 groups in the Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery (SYNTAX) score (41.7±7.6 *vs.* 42.8±8.3; P=0.603), but compared to the improved group, preoperative myocardial scarring was significantly enlarged in the unimproved group (41.9%±6.4% *vs.* 27.8%±8.5%; P<0.001). In regression analysis, only preoperative myocardial scarring [odds ratio (OR) =1.44; 95% confidence interval (CI): 1.13–1.83; P=0.003] was associated with no change in cardiac function evaluated by echocardiography after CABG. The median follow-up of 1.6 years (range, 0.6–4.1 years) found that the unimproved group had a higher incidence of major adverse cardiovascular and cerebrovascular events (MACCEs) (8.1% *vs.* 25.0%; P=0.044), and that the New York Heart Association (NYHA) classification of the unimproved group was higher than that of the improved group (P=0.018).

Conclusions: In ICM patients, a greater amount of preoperative myocardial scarring is associated with unimproved cardiac function after CABG. The measurement of preoperative myocardial scarring may aid clinicians in identifying patients who would benefit from CABG.

Keywords: Ischemic cardiomyopathy (ICM); coronary artery bypass grafting (CABG); cardiac magnetic resonance-late gadolinium enhancement; unimproved cardiac function

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Introduction

Coronary artery bypass grafting (CABG) has become the primary treatment for patients with ischemic cardiomyopathy (ICM) (1). However, such patients have a high surgical mortality rate and a high incidence of adverse events, and their prognosis is closely related to the improvement of postoperative cardiac function (2,3). According to a report (4), nearly 40% of ICM patients have no improvement in cardiac function after CABG, which increases their risk of death from any cause. Scars cannot be revascularized, and cardiac magnetic resonance with late gadolinium enhancement (CMR-LGE) is the gold standard for detecting myocardial scarring (5). The goal of this study was to analyze cardiac function associated with global preoperative myocardial scarring assessed by CMR-LGE in patients with ICM after CABG. We present the following article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-846/rc).

Methods

Participants

The study was conducted in accordance with the Declaration of Helsinki (revised in 2013). Approval from the Ethics Committee of Anzhen Hospital Affiliated to Capital Medical University was obtained before the study (No. 2021104X) and individual consent for this retrospective analysis was waived. This was a single-center, retrospective, observational cohort study. Between September 2017 and September 2021, 129 patients diagnosed with ICM and who received preoperative CMR-LGE at Beijing Anzhen Hospital were enrolled in the study. According to the inclusion and exclusion criteria, 57 patients were finally analyzed. The inclusion criteria were as follows: (I) left ventricular ejection fraction (LVEF) of less than or equal to 40% on transthoracic echocardiography; (II) diagnosis of coronary heart disease by percutaneous coronary angiography and subsequent CABG; (III) preoperative CMR-LGE and 6-month postoperative evaluation of cardiac function by echocardiography; (IV) follow-up coronary computed tomography angiography (CTA) showing patency of the bypass grafts; and (V) complete clinical dataset. The exclusion criteria were as follows: (I) acute myocardial infarction within the previous 3 months; (II) concurrent combined cardiac surgery (such as aortic valve, mitral valve, tricuspid valve, congenital heart disease, great vascular disease, ventricular aneurysm resection, etc.); (III) concomitant arrhythmias, such as atrial fibrillation; (IV) preoperative complications, such as a malignant tumor and chronic renal failure; and/or (V) preoperative emergency surgery performed for cardiogenic shock.

Among the 129 patients, 6 received drug treatment, 33 underwent mitral valve surgery, 4 underwent tricuspid valve surgery, 19 underwent aneurysm resection, and 67 patients received CABG surgery alone. Of those 67 patients, 2 died of postoperative low cardiac output syndrome, 2 failed to follow up 6 months after surgery, 3 had bypass grafts failure 6 months postoperatively, and 3 patients could not be accurately assessed for preoperative myocardial scarring. As a result, 57 patients were included in this study (*Figure 1*).

Study protocol

Clinical baseline characteristics, such as demographic information, echocardiography, and CMR-LGE data, were collected retrospectively. The patients' follow-up information was collected via phone, WeChat, or outpatient clinic records. Based on the results of transthoracic echocardiography 6 months after CABG surgery, the patients were divided into the following 2 groups: the improved cardiac function group, defined as change of LVEF (ΔLVEF) greater than or equal to 5% (6), and the no improved cardiac function group, defined as ΔLVEF less than 5%. The baseline characteristics of the 2 groups were compared to analyze the risk factors for cardiac function failure after CABG.

CMR-LGE image acquisition

The CMR-LGE examination was performed on patients 1 week before CABG surgery, and images were collected in the supine position. A 3.0 T superconducting magnetic resonance system was adopted (Verio; Siemens Medical Solutions, Erlangen, Germany), and 32 channels were dedicated to the heart phase-controlled front coil. All sequences were gated by electrocardiogram. Phase-sensitive inversion recovery (PSIR) magnetic moments were used to prepare rapid small-angle excitation sequences for late enhancement of cardiac imaging approximately 10 minutes after intravenous injection of 0.1 mmol/kg of gadopentetate dimeglumine contrast agent under the following conditions: repeat time/echo time, 4.1 ms/1.56 ms; field of view,

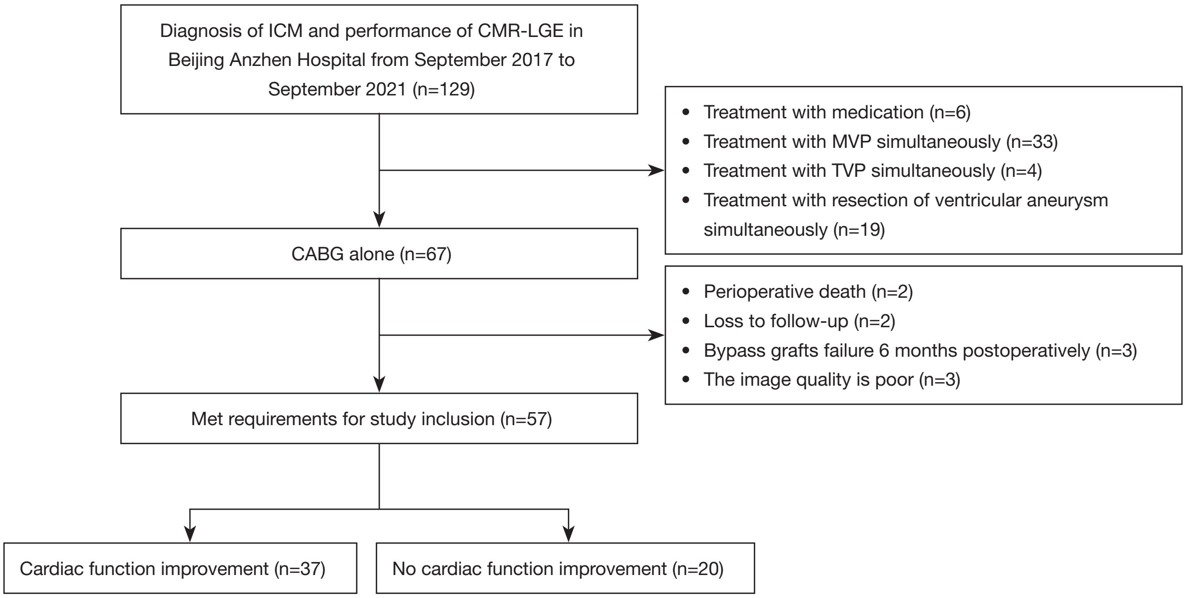

Figure 1 Flowchart of patient recruitment. ICM, ischemic cardiomyopathy; CMR-LGE, cardiac magnetic resonance-late gadolinium enhancement; MVP, mitral valve plasty; TVP, tricuspid valve plasty; CABG, coronary artery bypass grafting.

350 mm^2; matrix, 2.1 mm × 1.4 mm × 5.0 mm; turn angle, 35°; and, acceleration factor, 2. The thickness of the left ventricular short-axis imaging layer was 8 mm, with an interval of 0 mm. The imaging layers of the left ventricular 2-heart cavity and 4-heart cavities were both 5 mm thick without any separation.

CMR-LGE image post-processing

Left ventricular myocardial activity was analyzed using the cvi42 v 5.14.0 (Circle Cardiovascular Imaging Inc., Calgary, AB, Canada) post-processing software. The analysis was conducted by an associate senior radiologist with at least 5 years of CMR-LGE experience. The radiologist was unaware of the clinical data and information used to group the patients. The endocardium and epicardium (excluding papillary muscle) were delineated at the short axis level of the PSIR sequence, and the interventricular septum insertion point was marked at the short axis level to delineate the region of the normal myocardium. Normal myocardium was defined as having no LGE and being distant from the LGE area, whereas scarred myocardium was defined as being within the LGE area. The LGE region was defined as the myocardial gray threshold 5 standard deviations above the normal myocardium mean. By subtracting the end-diastolic pericardium volume and then multiplying it by 1.05 g/cm^3, the software calculated the left ventricular myocardial mass (LV mass) and late gadolinium enhancement mass (LGE mass) and then calculated the percentage of cardiac scar (LGE mass/LV mass × 100%) (*Figure 2*).

Surgical techniques

All patients underwent medial sternotomy. Depending on the patient's condition and the surgeon's experience, off-pump or on-pump CABG was performed. The skeletal or pedicled method was used to obtain the internal mammary artery, and the open technique was used to obtain the great saphenous vein. The left internal mammary artery was preferred for transplantation to the left anterior descending branch, and the great saphenous vein was sequentially branched out to other coronary arteries. All patients had anatomically complete revascularization (7), which implied that revascularization was performed for vessels with a coronary artery diameter of more than 1.5 mm and a stenosis of 50% or more, with at least one location indicated by coronary angiography. The quality of bridge anastomosis was evaluated using transit time flow measurement.

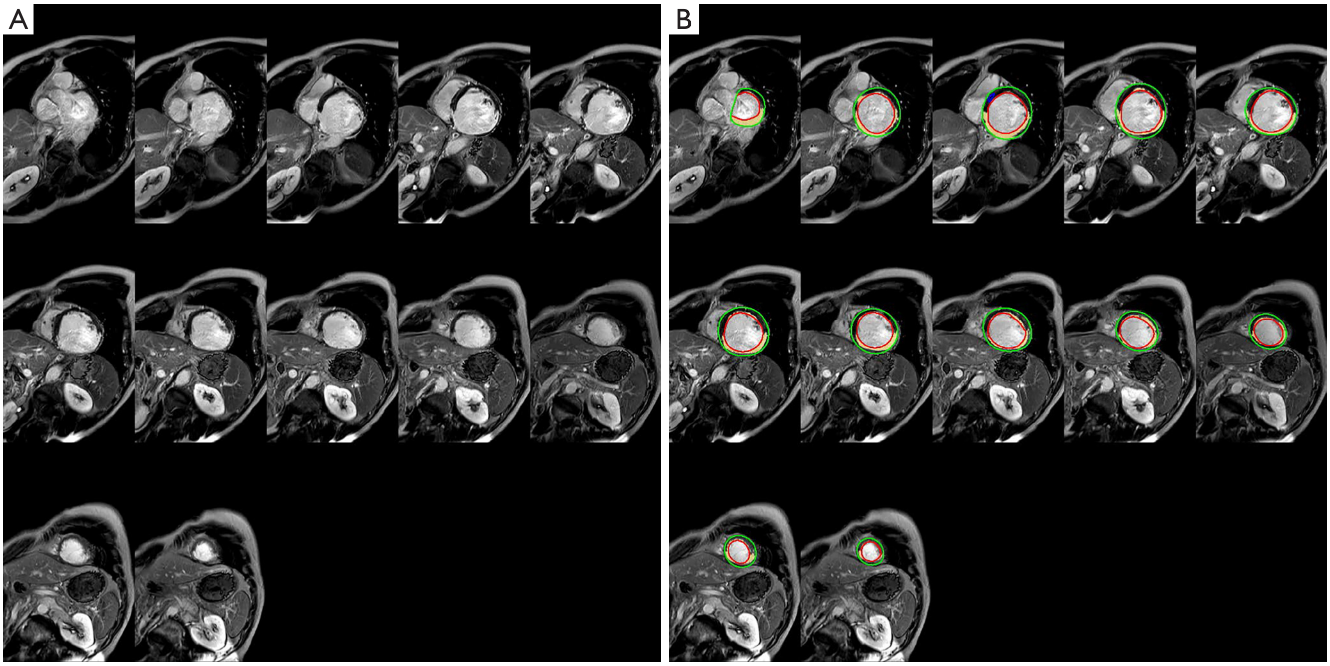

Figure 2 Identification and quantification of scar myocardium by CMR-LGE. (A) A typical LGE image is obtained on a continuous short-axis section. (B) Myocardial scarring (yellow) is detected after delineating the left ventricular endocardium (red) and epicardium (green). This image is published with the participant's consent. CMR-LGE, cardiac magnetic resonance late gadolinium enhancement.

Postoperative management and medical therapy

The patients were returned to the intensive care unit (ICU) with tracheal intubation and given electrocardiogram monitoring, ventilator-assisted breathing, and hemodynamic monitoring. Arterial blood gas analysis was performed immediately after surgery, on the first day after surgery, and before removal of the endotracheal intubation, to facilitate timely adjustment of the water and electrolyte metabolism and acid-base balance disorders. All patients received guideline-directed medical therapy after undergoing CABG (1), including the following: renin-angiotensin system inhibitors, such as an angiotensin-converting enzyme inhibitor, an angiotensin type II receptor blocker, or an angiotensin receptor and neprilysin inhibitor; a beta-blocker; and a mineralocorticoid receptor antagonist, such as spironolactone, in addition to long-term antiplatelet drugs.

Follow-up

These patients were followed up regularly at 3 and 6 months postoperatively and then every 6 months. If patients presented with symptoms of heart failure or coronary heart disease after surgery, they should be followed up at that time to adjust medication and other treatments. At follow-up, cardiac function improvement, New York Heart Association (NYHA) classification, and the occurrence of major adverse cardiovascular and cerebrovascular events (MACCEs) were evaluated. After 6 months, improvement in cardiac function was defined as ΔLVEF greater than or equal to 5% on transthoracic echocardiography. The MACCEs included all-cause death, myocardial infarction, stroke, and readmission for heart failure. Meanwhile, the patency of bridge vessels was evaluated using coronary CTA. The patency of bridge vessels was assessed using the Fitzgibbon classification system (8), with Fitzgibbon-A considered patency and Fitzgibbon-B/O considered occlusion. All patient data were obtained from our institution's online database and collected using standardized data collection forms by trained staff who were unaware of the purpose of this study.

Statistics analysis

The Student's *t*-test presented the normal distribution

Table 1 Preoperative baseline data of the two groups

Variables	Improved (n=37)	Unimproved (n=20)	P value
Age (years)	61.0±10.7	59.6±8.0	0.591
Male	26 (70.3)	19 (95.0)	0.065
BMI (kg/m²)	25.3±3.0	24.5±2.0	0.305
BSA (m²)	1.78±0.2	1.81±0.2	0.481
Medical history			
Hypertension	17 (45.9)	7 (35.0)	0.424
Diabetes	15 (40.5)	5 (25.0)	0.241
Hyperlipemia	15 (40.5)	6 (30.0)	0.431
Smoking	16 (43.2)	12 (60.0)	0.227
Drinking	11 (29.7)	6 (30.0)	0.983
Cerebral infarction	5 (13.5)	2 (10.0)	1.000
Echocardiography			
LVEF (%)	36.4±4.1	35.4±3.6	0.353
LVEDD (mm)	57.4±5.8	60.9±6.4	0.042
LVESD (mm)	43.7±6.7	49.2±7.4	0.008
IVST (mm)	9.9±2.0	9.2±1.9	0.208
LVPWT (mm)	8.4±1.8	8.3±1.5	0.832
LVEDVI (mL/m²)	112.9±25.4	134.9±27.3	0.004
LVESVI (mL/m²)	79.4±23.8	100.4±25.7	0.003
LVSVI (mL/m²)	33.5±9.6	34.4±9.8	0.748
Coronary lesion			0.780
One lesion	1 (2.7)	1 (5.0)	
Two lesions	7 (18.9)	4 (20.0)	
Three lesions	29 (78.4)	15 (75.0)	
SYNTAX score	41.7±7.6	42.8±8.3	0.603
NYHA class			0.556
I	2 (5.4)	1 (5.0)	
II	17 (45.9)	8 (40.0)	
III	12 (32.4)	6 (30.0)	
IV	6 (16.2)	5 (25.0)	
Myocardial scarring (%)	27.8±8.5	41.9±6.4	<0.001

Data are presented as n (%) or mean ± standard deviation. BMI, body mass index; BSA, body surface area; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; IVST, interventricular septal thickness; LVPWT, left ventricular posterior wall thickness; LVEDVI, left ventricular end-diastolic volume index; LVESVI, left ventricular end-systolic volume index; LVSVI, left ventricular stroke volume index; SYNTAX, Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery; NYHA, New York Heart Association.

measurement data as mean ± standard deviation, the Mann-Whitney U test presented the non-normal distribution measurement data as median (M) and quartile spacing [M (P25, P75)], and the chi-square test or Fisher's exact test as frequency (rate) presented the count data as frequency (rate). Univariate logistic regression analysis examined the relationship between variables and no improvement in cardiac function. The multivariate logistics regression analysis included the univariate analysis of variables with P<0.05 and those thought to be clinically related to endpoint events. The Kaplan-Meier method was used to calculate the MACCE-free survival curves of the 2 groups. The log-rank test was used to check if the survival curves of the 2 groups differed. For the data analysis, the software packages SPSS 23.0 (IBM Corp., Armonk, NY, USA) and Stata 16 (StataCorp, College Station, TX, USA) were used.

Results

Preoperative baseline data of the 2 groups

At 6 months after CABG, 37 patients (64.9%) showed improvement in cardiac function, but 20 patients (35.1%) did not. The average age was 60.5±9.8 years (range, 39–84 years), and 78.9% (45/57) were males. There were no statistical differences in age, body mass index (BMI), body surface area (BSA), medical history, and degree of coronary lesion between the 2 groups (P>0.05). The unimproved group had significantly higher left ventricular end-diastolic diameter (LVEDD), left ventricular end-systolic diameter (LVESD), ventricular wall thickness, left ventricular end-diastolic volume index (LVEDVI), and left ventricular end-systolic volume index (LVESVI) than the improved group. The degree of myocardial scarring in the unimproved group was significantly higher than that in the improved group (41.9%±6.4% *vs.* 27.8%±8.5%; P<0.001; *Table 1*).

Comparison of surgical data between the 2 groups

A bilateral internal mammary artery bypass was not used in either group. There were no significant differences between the 2 groups in the use of cardiopulmonary bypass, left internal mammary artery utilization rate, number of bypass procedures, operation time, and blood product dosage (P>0.05). Although the ICU stay time, ventilator use time, and postoperative hospital stay in the unimproved group were higher than those in the improved group, the differences were not statistically significant (P>0.05; *Table 2*).

Table 2 Operation data of the 2 groups

Variables	Improved (n=37)	Unimproved (n=20)	P value
Off-pump	25 (67.6)	15 (75.0)	0.558
LIMA	36 (97.3)	19 (95.0)	0.653
Number of grafts	3.5±0.6	3.7±0.37	0.353
Operation time (h)	4.1±0.9	4.1±0.7	0.958
Erythrocytes (μ)	0 (0, 4)	0 (0, 1.5)	0.489
Plasma (mL)	0 (0, 0)	0 (0, 0)	0.762
Platelets (μ)	0 (0, 0)	0 (0, 0)	0.473
ICU stay time (h)	46.0 (22.5, 67.5)	48.0 (26.9, 87.3)	0.358
Ventilator use time (h)	25.0 (18.5, 46.0)	34.0 (23.8, 55.6)	0.068
Postoperative hospital time (days)	7.0 (6.0, 8.0)	8.0 (6.3, 11.8)	0.134

Data are presented as n (%), mean ± standard deviation or median (first quartile, third quartile). LIMA, left internal mammary artery; ICU, intensive care unit.

Table 3 Comparison of echocardiography data between the two groups preoperatively and six months postoperatively ($\bar{x}$ ± s)

Variables	Improved (n=37)			Unimproved (n=20)			P value
	Pre-op	6 months	Δ	Pre-op	6 months	Δ	
LVEF (%)	36.4±4.1	51.2±5.6	10.2±5.9	35.4±3.6	37.7±5.6	0.7±4.4	<0.001
LVEDD (mm)	57.4±5.8	52.7±3.5	−4.7±5.5	60.9±6.4	59.4±6.5	−1.1±6.1	0.029
LVESD (mm)	43.7±6.7	38.4±3.8	−5.5±6.3	49.2±7.4	47.3±6.2	−1.4±6.6	0.027
LVEDVI (mL/m²)	112.9±25.4	85.1±18.6	−27.8±28.3	134.9±27.3	126.8±20.7	−8.1±37.8	0.030
LVESVI (mL/m²)	79.4±23.8	40.7±11.5	−38.6±23.0	100.4±25.7	91.3±12.4	−9.1±28.4	<0.001
LVSVI (mL/m²)	33.5±9.6	44.4±13.5	10.9±16.2	34.4±9.8	35.5±13.4	1.1±19.7	0.048

Data are presented as mean ± standard deviation. Pre-op, preoperative; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LVEDVI, left ventricular end-diastolic volume index; LVESVI, left ventricular end-systolic volume index; LVSVI, left ventricular stroke volume index.

Comparison of echocardiographic data between the 2 groups preoperatively and 6 months postoperatively

The results of preoperative and postoperative echocardiographic follow-up revealed that the LVEF and LVSVI were significantly increased 6 months after surgery in the improved group compared with the preoperative results, yet the LVEDD, LVESD, LVESVI, and LVEDVI were significantly decreased. Simultaneously, the LVEF, left ventricular size, and left ventricular volume were not significantly changed in the unimproved group. The differences between the 2 groups before and after the operation showed that the improved group had better improvement in left ventricular function (P<0.05), left ventricular size (P<0.05), and left ventricular volume (P<0.05), as shown in *Table 3*.

Factors associated with failure to improve cardiac function

In ICM patients, univariate analysis showed that left ventricular size, left ventricular volume, and myocardial scarring were factors associated with no improvement in cardiac function after CABG. Multivariate regression analysis of these variables revealed that only myocardial scarring was a risk factor for no improvement in cardiac function (OR =1.44; 95% CI: 1.13–1.83; P=0.003; *Table 4*).

Table 4 Results of univariate and multivariate analyses predicting no improvement in cardiac function

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
LVEDD (mm)	1.11 (1.00–1.22)	0.048	0.81 (0.54–1.22)	0.318
LVESD (mm)	1.12 (1.02–1.22)	0.014	1.28 (0.86–1.92)	0.227
LVEDVI (mL/m²)	1.03 (1.01–1.06)	0.008	1.05 (0.93–1.19)	0.451
LVESVI (mL/m²)	1.04 (1.01–1.06)	0.007	1.00 (0.88–1.13)	0.999
Myocardial scar (%)	1.34 (1.15–1.56)	<0.001	1.44 (1.13–1.83)	0.003

Data are presented as median (first quartile, third quartile). OR, odds ratio; CI, confidence interval; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LVEDVI, left ventricular end-diastolic volume index; LVESVI, left ventricular end-systolic volume index.

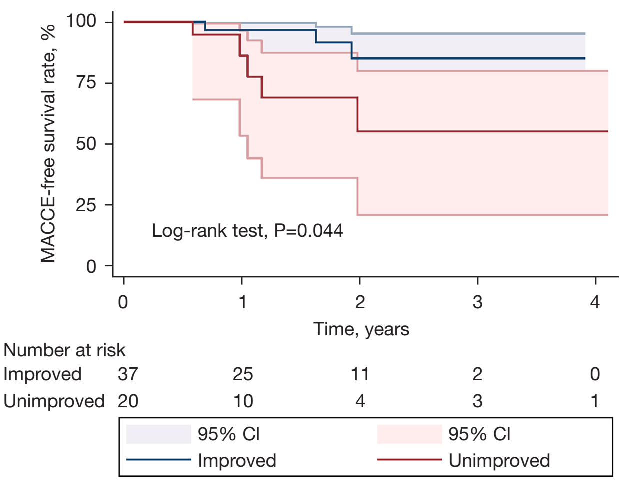

Figure 3 A Kaplan-Meier curve was used to plot MACCE-free survival curves for the improved group (blue) and the unimproved group (red); log-rank test, P=0.044. MACCE, major adverse cardiovascular and cerebrovascular event; CI, confidence interval.

Table 5 Follow-up results of the improved and unimproved groups

Variables	Improved (n=37)	Unimproved (n=20)	P value
MACCE	3 (8.1)	5 (25.0)	0.044
NYHA class			0.018
I	6 (16.2)	2 (10.0)	
II	26 (70.3)	9 (45.0)	
III	4 (10.8)	5 (25.0)	
IV	1 (2.7)	4 (20.0)	

Data are presented as n (%). MACCE, major adverse cardiovascular and cerebrovascular events; NYHA, New York Heart Association.

The incidence of MACCEs

After a median follow-up of 1.6 years (range, 0.6–4.1 years), 3 patients in the improved group and 5 patients in the non-improved group developed MACCE, with 1 patient dying, 1 experiencing a stroke, and 1 being readmitted for heart failure in the improved group, and 5 deaths in the non-improved group. According to the Kaplan-Meier survival analysis, the incidence of MACCE in the unimproved group was significantly lower than in the improved group (P=0.044; *Figure 3*). Meanwhile, the improved group had a lower NYHA classification and significantly reduced heart failure symptoms (P=0.018; *Table 5*).

Discussion

This study yielded the following findings. Firstly, 35.1% of ICM patients had improved cardiac function 6 months after CABG. Secondly, preoperative myocardial scarring was shown to be an independent risk factor for failure to improve cardiac function following CABG. We had hoped to use receiver operating characteristic curves to detect the cut-off value of preoperative myocardial scarring to assist in predicting unimproved cardiac function after CABG, but it was inaccurate as a slight tweaking of endocardial and epicardial contours on CMR-LGE changed the LGE%, and the sample size was also small. Thirdly, we found that no improvement in cardiac function was associated with a poorer mid-term prognosis. The group with improved cardiac function had better outcomes than those without improvement, helping to identify the benefits for CABG patients.

CABG has become the primary treatment for ICM patients (1). However, different studies on whether cardiac function improves after CABG in ICM patients have reported conflicting results. A previous study (9) found that 50% of ICM patients had improved cardiac function 7 days after CABG. Another study (10) found that 35% of patients had improved cardiac function three months after CABG. Another report (11) found that 73% (51/70) of patients had improved cardiac function 1 year after CABG. According to the most recent study (4), nearly 40% of patients had no improvement in cardiac function at an average of 64.5±45.5 months after CABG. There was no significant relationship between improvement in postoperative cardiac function and all-cause mortality. Similar to a previous study, 64.9% of patients had improved cardiac function 6 months after CABG, and 35.1% had no improvement. Patients with unimproved cardiac function had a higher incidence of MACCE than those with improved cardiac function.

Myocardial scarring is more accurate than viable myocardium in predicting the improvement of cardiac function (5,12-15). As a result, we can predict cardiac function improvement after CABG by assessing the degree of myocardial scarring. The myocardium is a non-regenerative cell, hence once myocardial scars are formed, even if blood supply is restored, the function of the scarred myocardium cannot be restored. Further, myocardial scarring may impair the movement of the surrounding myocardium. The tethering of myocardial scar tissue may cancel out the improvement in systolic activity brought on by viable myocardium, preventing an improvement in overall cardiac function. As a result, the degree of myocardial scarring may significantly impact cardiac function.

CMR-LGE imaging is an effective method for detecting and quantifying myocardial scarring (5). In previous research (15), myocardial scar segments (LGE >50%) less than or equal to 4 were found to be predictive of improved cardiac function after CABG in ICM patients. Other studies (11,12) have shown that the number of myocardial scar segments (≤6 or ≤2) can predict the improvement of cardiac function after CABG. In the same way that previous studies have investigated whether the number of segments of myocardial scarring improves cardiac function, the present study quantified the overall degree of myocardial scarring in the left ventricle using CMR-LGE and found that a greater amount of preoperative myocardial scarring was associated with unimproved cardiac function after CABG. The number of segments of myocardial infarction was not used as a predictor in this study because the results of various studies on the number of segments of myocardial scarring have been inconsistent. Simultaneously, Hwang *et al.* (16) have shown that, although the degree of LGE mural penetration is negatively correlated with the improvement of myocardial segment function, one-third of myocardium scar segments still have a chance of improvement after revascularization.

Myocardial scarring can be used to identify patients at higher risk of cardiovascular events and has some value in predicting patient prognosis (13,17,18). A single-center analysis (19) demonstrated the association between myocardial scarring and prognosis. A total of 631 ICM patients with LVEF ≤40% underwent CMR-LGE and found that myocardial scarring was an independent risk factor for cardiogenic death. Meanwhile, patients with the same degree of myocardial scarring who underwent revascularization had a similar risk of death to those who received only drug therapy. There was no improvement in survival of ICM patients regardless of whether revascularization was performed on myocardial scars. Gerber *et al.* (20) demonstrated this in a study of 144 patients, in which 86 received complete revascularization (92% CABG) and 58 received drug therapy. Following patients for 3 years, the researchers found that myocardial scarring, regardless of revascularization, was associated with a higher incidence of adverse events, suggesting that drug treatment is likely the best option for such patients. They also found that patients with unimproved cardiac function had a greater degree of myocardial scarring, which was consistent with the findings of this study, and unimproved cardiac function was associated with a less favorable mid-term prognosis (and higher incidence of MACCE).

This study evaluated the degree of myocardial scarring using CMR-LGE to identify whether cardiac function improved after CABG in ICM patients. Since no improvement in cardiac function has a significant adverse impact on patient prognosis, our findings are important for patients who cannot benefit from CABG. Alternative therapies are available for ICM patients who do not benefit from CABG (1,21), such as continued drug therapy, a permanent left ventricular assistance device, heart transplant, or cell therapy.

This study had several limitations. Firstly, the study was a single-center, retrospective, observational cohort study with a small sample size, which may have resulted in selection bias. Secondly, the slice gap during a CMR-LGE scan can affect the accurate measurement and calculation of myocardial scarring and affect the accuracy of predicting the improvement of cardiac function. Thirdly, this study only considered the overall degree of myocardial scarring present in the left ventricle but did not consider the distribution of myocardial scarring. The distribution of cardiac scarring may also be a potential factor influencing the improvement of cardiac function. In follow-up work, we will conduct additional research to address these gaps. Finally, patients failed to undergo another CMR-LGE examination during postoperative follow-up, resulting in a lack of dynamic evolution over time. This was because the outpatient CMR-LGE reexamination took 1–3 months, which affected the postoperative examination.

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Footnote

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