Original Article

The number of myocardial infarction segments connected to papillary muscle is associated with the improvement in moderate ischemic mitral regurgitation

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Background: We evaluated whether the number of myocardial infarction (MI) segments connected to the papillary muscle (PM), as assessed using cardiac magnetic resonance (CMR) with late gadolinium enhancement (LGE), predicts whether moderate ischemic mitral regurgitation (IMR) improves after isolated coronary artery bypass grafting (CABG) to guide the choice of surgical strategy.

Methods: A total of 54 patients diagnosed with coronary heart disease (CHD) complicated with moderate IMR who underwent isolated CABG were selected continuously in this retrospective study at Beijing Anzhen Hospital. All patients underwent preoperative LGE. The patients were divided into the IMR improved group (37 patients) and the unimproved group (17 patients) according to 1-year postoperative echocardiography. The factors associated with no IMR improvement after isolated CABG were analyzed. There was no trial registration and no publication of the study protocol.

Results: The number of MI segments connected to PM was an independent risk factor for no IMR improvement after isolated CABG [odds ratio 4.39; 95% confidence interval (CI): 1.93–9.98; $P<0.001$]. The optimal receiver operating characteristic (ROC) curve cut-off value for no IMR improvement was ≥2 (sensitivity: 82.4%; specificity: 83.8%). Follow-up at 1–5 years (median, 2.8 years) showed that the incidences of major adverse cardiovascular and cerebrovascular events (5.4% *vs.* 23.5%; P=0.041) and New York Heart Association (NYHA) grade (P=0.026) were higher in the unimproved group.

Conclusions: In patients with CHD complicated with moderate IMR, the number of MI segments connected to PM is an independent risk factor for no IMR improvement after isolated CABG. Mitral valve surgery should be performed simultaneously with CABG in patients with ≥2 MI segments connected to the PM.

Keywords: Late gadolinium enhancement (LGE); myocardial infarction segments connected to papillary muscle; coronary heart disease (CHD); moderate ischemic mitral regurgitation (IMR); coronary artery bypass grafting (CABG)

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Introduction

For patients with coronary heart disease (CHD) with moderate ischemic mitral regurgitation (IMR), It is still controversial that (1) which patients can improve IMR from coronary artery bypass grafting (CABG) and avoid the additional injury caused by combined mitral valve surgery (2,3) and which patients cannot improve IMR from CABG and should be required simultaneous mitral valve surgery.

Previous studies (4,5) showed that a greater left ventricular ejection fraction (LVEF) and a greater posterior-inferior volume ratio are predictors of an improvement in IMR after isolated CABG. Conversely, left ventricular dysfunction (LVEF ≤40%), dyssynchronous movement between papillary muscles (PMs), and abnormal movement of the anterior wall of the left ventricle (LV) are risk factors for no IMR improvement after isolated CABG (6-8). These indicators are evaluated by echocardiography, which can be used to assess the structure and function of the LV, but not myocardial scarring.

Cardiac magnetic resonance (CMR) with late gadolinium enhancement (LGE) is the gold-standard imaging method for detecting myocardial scarring caused by myocardial infarction (MI) (9). IMR is the result of remodeling in the LV after MI (10); however, there are few studies on IMR and local remodeling of the LV, and the relationship between local remodeling of the LV after CABG and the change in IMR is not clear. We hypothesized that the severity of local LV remodeling was related to the improvement of IMR after CABG. Therefore, the purpose of this study was to evaluate the severity of infarction in myocardial segments connected to PM using LGE to predict whether IMR improves after isolated CABG and to optimize the surgical strategy and improve prognosis. We present the following article in accordance with the STARD reporting checklist (available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-301/rc).

Methods

Patient enrollment

This is a single-center, retrospective, observational cohort study. Patients diagnosed with CHD complicated with moderate IMR who underwent an examination with LGE at Beijing Anzhen Hospital from January 2016 to December 2020 were selected continuously. The inclusion criteria were: (I) a diagnosis of moderate IMR by transthoracic echocardiography (11); (II) LGE and echocardiography within 10 days preoperatively; (III) accurate detection of myocardial scar tissue by LGE; (IV) complete anatomical revascularization (12); and (V) coronary computed tomography angiography (CTA) showing coronary bypass graft patency during the 1-year follow-up. The exclusion criteria were (I) organic mitral valve disease; (II) a history of mitral valve surgery; (III) coexistence of other heart valve diseases; (IV) long-term persistent atrial fibrillation and other arrhythmias; (V) preoperative emergency surgery for cardiogenic shock; and (VI) acute MI in the previous 3 months.

Study protocol

The patients' baseline clinical characteristics, including demographic information, echocardiography, and LGE data, were retrospectively collected. Follow-up information was collected by telephone, WeChat, or outpatient visits. The patients were divided into two groups: the improved group (no or mild IMR) and the unimproved group (moderate or severe IMR) based on the severity of IMR, as assessed by echocardiography 1 year postoperatively. The baseline characteristics were compared between the two groups to identify the independent risk factors for moderate or severe IMR 1 year after isolated CABG. All patients provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Ethics Committee of Beijing Anzhen Hospital (No. 2016024) and informed consent was obtained from all the patients.

Echocardiography

All patients underwent transthoracic echocardiography at rest within 1 week preoperatively and 1 year postoperatively. Transthoracic echocardiography was performed using a Vivid 7 color Doppler echocardiography system (GE Healthcare, Chicago, IL, USA). The severity of IMR was quantified according to the standard quantitative proximal isovelocity surface area method recommended by the European Cardiovascular Association (13). IMR was divided (11) into no regurgitation, mild IMR [IMR area of <4 cm^2, effective regurgitation orifice area (EROA) of <0.2 cm^2], moderate IMR (IMR area of 4–8 cm^2, EROA of 0.2–0.39 cm^2), and severe IMR (IMR area of >8 cm^2, EROA of ≥ 0.4 cm^2).

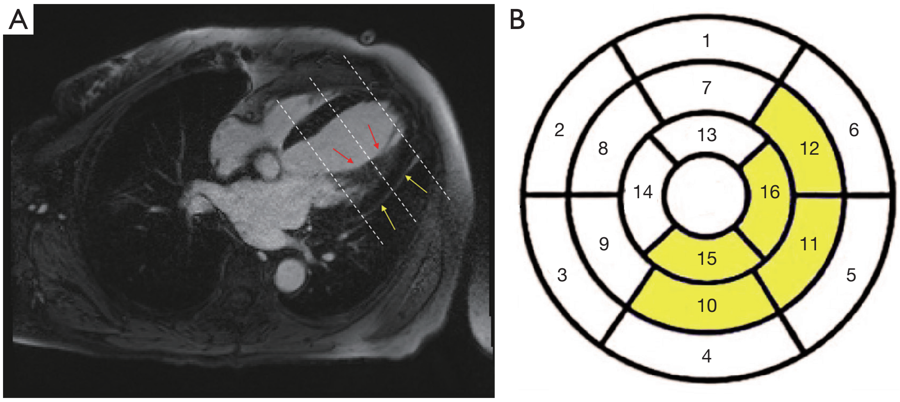

Figure 1 Transverse chest cardiac magnetic resonance scan and LV segment division. (A) The three white dashed lines divide the LV along its long axis into the basal segment, intermediate segment, and apex segment. The red arrows indicate the PM, and the yellow arrows indicate the myocardium connected to the PM. (B) Segments 1–6 comprise the basal segment, segments 7–12 comprise the intermediate segment, and segments 13–16 comprise the apex segment. The yellow parts (10, 11, 12, 15, and 16) are the five myocardial segments connected to PM. LV, left ventricular; PM, papillary muscle.

LV segmentation

According to the 17-segment heart zoning model proposed by the American Heart Association/College of Cardiology (14), the LV was divided into the basal segment, central segment, and apical segment along its long axis. The apex was too thin to be evaluated; thus, the apex segment was subtracted from the 17 segments, and the remaining 16 segments were analyzed. According to the anatomical characteristics of the PM and LV, the myocardium connected to PM is mainly located in the lower wall of the central segment [10], the proximal inferior lateral wall of the central segment [11], the proximal anterior lateral wall of the central segment [12], the lower wall of the apical segment [15], and the lateral wall of the apical segment [16] (*Figure 1*).

LGE examination and analysis

CMR with LGE was performed with a MAGNETOM Verio 3.0-T superconducting magnetic resonance system (Siemens Healthineers, Erlangen, Germany). Intravenous injection of gadopentetate dimeglumine contrast agent at 0.1 mmol/kg. Approximately, 10 minutes after LGE imaging was performed using phase-sensitive inversion recovery magnetic moment pre-preparation of a turbo fast low-angle shot stimulation (Turbo-FLASH) sequence.

When the LGE area was 0–50%, the segment was considered viable, and when the LGE area was 51–100%, the segment was considered as an MI segment. LGE of 50% was used as the optimal threshold to determine the viability of the myocardial segment and to predict whether the function of the segment improved after revascularization (15,16). If PM enhancement was seen on images with LGE, PM infarction (PMI) was considered. The degree of global myocardial remodeling of the LV was measured by the number of MI segments in the global LV, and the degree of local myocardial remodeling of the LV was measured by the number of MI segments connected to PM. Commercial cardiovascular post-processing software (cvi42; Circle Cardiovascular Imaging Inc., Calgary, Canada) was used for analysis. This was performed by a radiologist with 5 years of CMR experience who was unaware of the patients' clinical data and grouping information.

Surgical techniques

A conventional sternal median incision was made. The internal mammary artery was obtained by ossification or pedicling, and the great saphenous vein was obtained using an open technique. Transplantation of the left internal mammary artery to the left anterior descending branch was the first-choice technique, and the great saphenous vein was sequentially anastomosed to other coronary arteries. Complete revascularization was performed in all patients (12). Off-pump or on-pump CABG was performed according to the patient's condition and surgeon's experience. Transit-time flow measurement was used to evaluate the quality of coronary bypass vessel anastomosis.

Postoperative management and medical therapy

The patients were returned to the intensive care unit with tracheal intubation and given ECG monitoring, ventilator assisted breathing, and hemodynamic monitoring. Arterial blood gas analysis was performed immediately after operation, on the first day after operation and before pulling out the endotracheal intubation, in order to timely adjust the water and electrolyte metabolism and acid-base balance disorders. Dual antiplatelet drugs were given on the first day after operation. Patients with heart failure and a reduced LVEF were treated with guideline-directed medical therapy, including angiotensin converting enzyme inhibitors (ACEIs), angiotensin-receptor blockers (ARBs), beta blockers, aldosterone antagonists, and/or sacubitril/valsartan (17).

Follow-up

The patients were followed up at 3 and 6 months postoperatively and every 6 months thereafter. Follow-up mainly included an assessment of whether IMR improved, New York Heart Association (NYHA) functional class, and the incidence of major cardiovascular and cerebrovascular events (MACCEs). An improvement in IMR was defined as no or mild MR, and no IMR improvement was defined as moderate or severe IMR by transthoracic echocardiography at 1 year after CABG. MACCEs included all-cause death, MI, heart failure, cerebrovascular events, and rehospitalization for heart disease. Coronary CTA results were also recorded. The patency of coronary bypass vessels was examined by coronary CTA and assessed according to the Fitzgibbon classification system (18). All patients' data were obtained from our institution's online database and collected using standardized data collection forms.

Statistical analysis

The Student's *t*-test was used for normally distributed measurement data, which are expressed as mean ± standard deviation. The Mann-Whitney U test was used for non-normally distributed measurement data, which are expressed as median and interquartile range (P25, P75). The chi-square test or Fisher's exact test was used for count data, which are expressed as frequency (rate). The Kaplan-Meier method was used to calculate the MACCEs-free survival curves of the two groups. The log-rank test was used to identify differences in the survival curves between the two groups. The univariate logistic regression analysis was used to assess the relationship between variables and no IMR improvement. Variables with a P value of <0.2 in the univariate logistic regression analysis and variables reported in previous studies, as well as variables considered clinically closely related to the endpoint events, were included in the multivariate logistic regression analysis using the forward stepwise method. The receiver operating characteristic (ROC) curve analysis was used to calculate the area under the curve (AUC), and the maximum Youden index (sensitivity + specificity − 1) determined the cut-off value for no IMR improvement after isolated CABG. All statistical tests were two-sided, and a P value of <0.05 was considered statistically significant. SPSS version 23.0 (IBM Corporation, Armonk, NY, USA) and R 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria) were used for statistical analysis.

Results

A total of 126 patients diagnosed with CHD complicated with moderate IMR who underwent an examination with LGE at Beijing Anzhen Hospital from January 2016 to December 2020 were continuously enrolled. Of the 126 patients, 3 received medication, 48 underwent mitral valve plasty (MVP) during CABG, and 14 had other heart diseases and underwent cardiac surgery. Sixty-one patients underwent isolated CABG; of these patients, 2 died of low cardiac output syndrome and heart failure postoperatively, 2 were lost to follow-up 1 year postoperatively, and 3 developed coronary bypass vessel occlusion 1 year postoperatively. Therefore, 54 patients with CHD complicated with moderate IMR who underwent isolated CABG were included in this study (*Figure 2*).

The mean age of the patients was 64.4±9.0 years (range, 43–84 years), and 72.2% of the patients (39/54) were male. IMR improved (no or mild IMR) in 37 patients (68.5%) at 1 year after CABG, while no improvement was noted in 17 patients (31.5%) at 1 year after CABG, including 15 patients (27.8%) with moderate IMR and 2 patients (3.7%) with severe IMR. There were no significant differences in age, sex, body mass index, and other demographic characteristics between the two groups (P>0.05) (*Table 1*).

There were no significant differences in LVEF, LV size, and incidence of PMI between the two groups (all P>0.05). However, the number of MI segments in the global LV

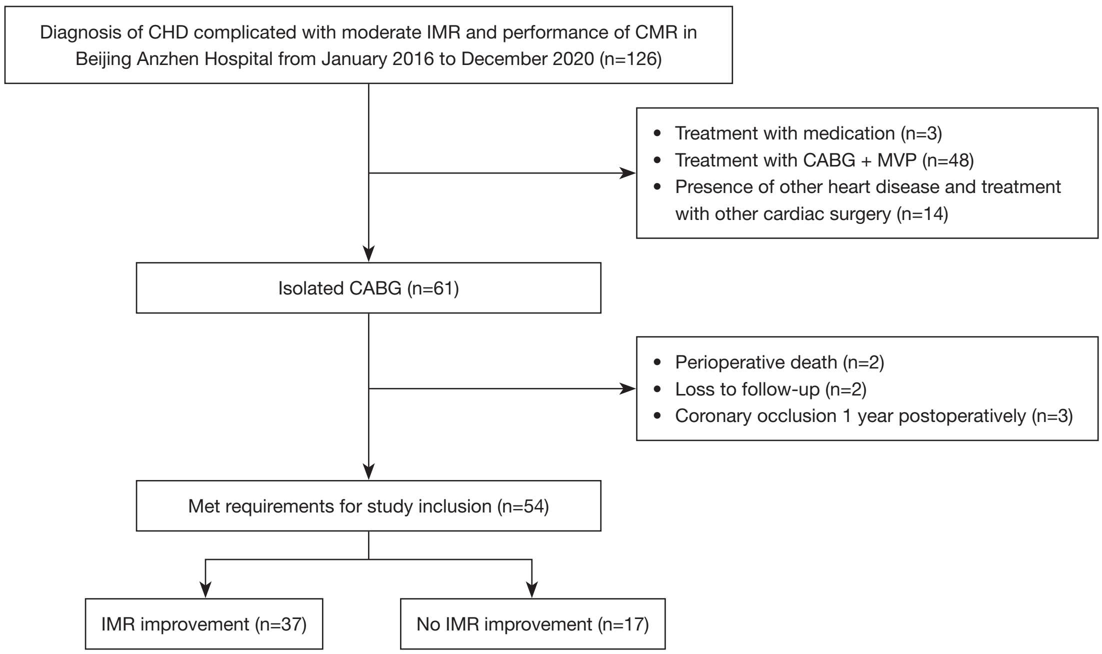

Figure 2 Flowchart of patient screening. CHD, coronary heart disease; IMR, ischemic mitral regurgitation; CMR, cardiac magnetic resonance; CABG, coronary artery bypass grafting, MVP, mitral valve plasty.

Table 1 Demographic characteristics of patients in the two groups

Variable	Improved (n=37)	Unimproved (n=17)	P values
Age (y)	63.6±9.9	66.3±6.6	0.308
Age >65 years	17 (45.9)	8 (47.1)	0.939
Male	28 (75.7)	11 (64.7)	0.611
BMI (kg/m²)	25.6±2.9	24.8±2.3	0.349
BSA (m²)	1.79±0.2	1.75±0.2	0.381
Hypertension	19 (51.4)	10 (58.8)	0.609
Diabetes	11 (29.7)	3 (17.6)	0.544
Hyperlipidemia	13 (35.1)	9 (52.9)	0.216
The history of PCI	4 (10.8)	2 (11.8)	1.000
Smoking	17 (45.9)	6 (35.3)	0.462
Drinking	11 (29.7)	4 (23.5)	0.884
COPD	2 (5.4)	0 (0.0)	1.000
Cerebral infarction	6 (16.2)	4 (23.5)	0.791
PAD	18 (48.6)	9 (52.9)	0.770

The data are presented as mean ± SD or n (%). BMI, body mass index; BSA, body surface area; PCI, percutaneous coronary intervention; COPD, chronic obstructive pulmonary disease; PAD, peripheral artery disease.

in the unimproved group was significantly higher than in the improved group [4 (3.0, 6.5) *vs.* 1.0 (0, 3.0); P=0.001], and the number of MI segments connected to PM in the unimproved group was higher [2.0 (2.0, 2.5) *vs.* 0 (0, 1.0); P<0.001] (*Table 2*). *Figure 3* shows the CMR-LGE images, preoperative and postoperative echocardiography images of a patient whose IMR not improved at 1 year after isolated CABG. *Figure 4* shows the CMR-LGE images, preoperative and postoperative echocardiography images of a patient whose IMR improvement at 1 year after isolated CABG.

The clinical data of patients including LVEF, LV end-diastolic diameter (LVEDD), PMI, number of MI segments in the global LV, and number of MI segments connected to PM were included in the multivariate regression equation. The multivariate analysis showed that the number of MI segments connected to PM [odds ratio (OR) 4.39, 95% confidence interval (CI): 1.93–9.98; P<0.001] was associated with no IMR improvement after isolated CABG (*Table 3*). The ROC curve analysis showed that a cut-off value of ≥2 MI segments connected to PM was optimal for predicting an improvement in IMR (*Figure 5*), with a sensitivity of 82.4% and a specificity of 83.8%. The AUC was 0.86 (95% CI: 0.75–0.96). A cross-tabulation of preoperative LGE area and 1-year postoperative echocardiography is shown in *Table 4*.

Table 2 Echocardiography and LGE variables

Variables	Improved (n=37)	Unimproved (n=17)	P values
Echocardiogram			
LVEF (%)	48.9±10.6	44.4±11.1	0.156
LVEDD (mm)	56.0±7.6	55.7±10.8	0.904
LVESD (mm)	41.7±8.5	42.7±12.5	0.738
IMR area (cm²)	5.6±1.1	5.5±1.3	0.646
EROA (cm²)	0.30±0.07	0.34±0.11	0.264
LGE			
PMI	25 (67.6)	13 (76.5)	0.506
Number of MI segments in global LV	1.0 (0, 3.0)	4.0 (3.0, 6.5)	0.001
Number of MI segments connected to PM	0 (0, 1.0)	2.0 (2.0, 2.5)	<0.001
MI segments connected to PM ≥2	6 (16.2)	14 (82.4)	<0.001

The data are presented as mean ± SD, n (%), or median (range). LGE, late gadolinium enhancement; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; IMR, ischemic mitral regurgitation; EROA, effective regurgitation orifice area; PMI, papillary muscle infarction; MI, myocardial infarction; LV, left ventricle; PM, papillary muscle.

Echocardiography showed no significant differences in LVEF, LVEDD, and LV end-systolic diameter between the improved group and the unimproved group at 1 year postoperatively (all P>0.05). However, IMR area and the EROA were significantly lower in the improved group than in the unimproved group (P<0.05). These patients were followed up for 1–5 years (median, 2.8 years), and the unimproved group had a significantly higher incidence of MACCEs than the improved group (P=0.041) (*Figure 6*). Among them, two patients in the improved group developed MACCEs (rehospitalization for heart disease), and four patients in the unimproved group developed MACCEs (two patients with all-cause death and two patients with rehospitalization for heart disease). The NYHA functional class was significantly higher in the unimproved group than in the improved group (P=0.026) (*Table 5*).

Discussion

This study presents some important findings. First, among patients with moderate IMR, 31.5% demonstrated no IMR improvement at 1 year after isolated CABG. Second, the number of MI segments connected to PM was a predictor of no IMR improvement after isolated CABG. The ROC curve analysis showed that ≥2 MI segments connected to PM could predict no IMR improvement after isolated CABG, with good sensitivity and specificity. Third, patients with no IMR improvement had a poorer intermediate outcome and a higher NYHA functional class than patients with IMR improvement. Therefore, for patients with moderate IMR, LGE can be used to evaluate the number of MI segments connected to PM to predict whether IMR improves after isolated CABG, thus guiding the selection of surgical strategy.

The crux of the current controversy is that the intervention strategy for concurrent mitral valve surgery in patients with CHD complicated with moderate IMR is unclear (1). To date, the largest randomized controlled trial of the Cardiothoracic Surgery Trial Network study (2) showed that although CABG + MVP could more effectively improve mitral regurgitation, it did not improve postoperative survival or reduce the overall incidence of adverse events and hospital readmission, and it was associated with early nervous system events (cerebral infarction, transient ischemic attack, and metabolic encephalopathy) and supraventricular arrhythmia. Therefore, rather than determining what type of surgery is the best option for these patients, the surgeon might consider which patients are suitable for CABG versus CABG combined with mitral valve surgery. This study analyzed patients receiving isolated CABG and found that nearly 1/3 of the patients had no IMR improvement, and the incidence of MACCE and NYHA functional class were higher than in the improved group.

IMR is a result of local LV remodeling caused by inferior

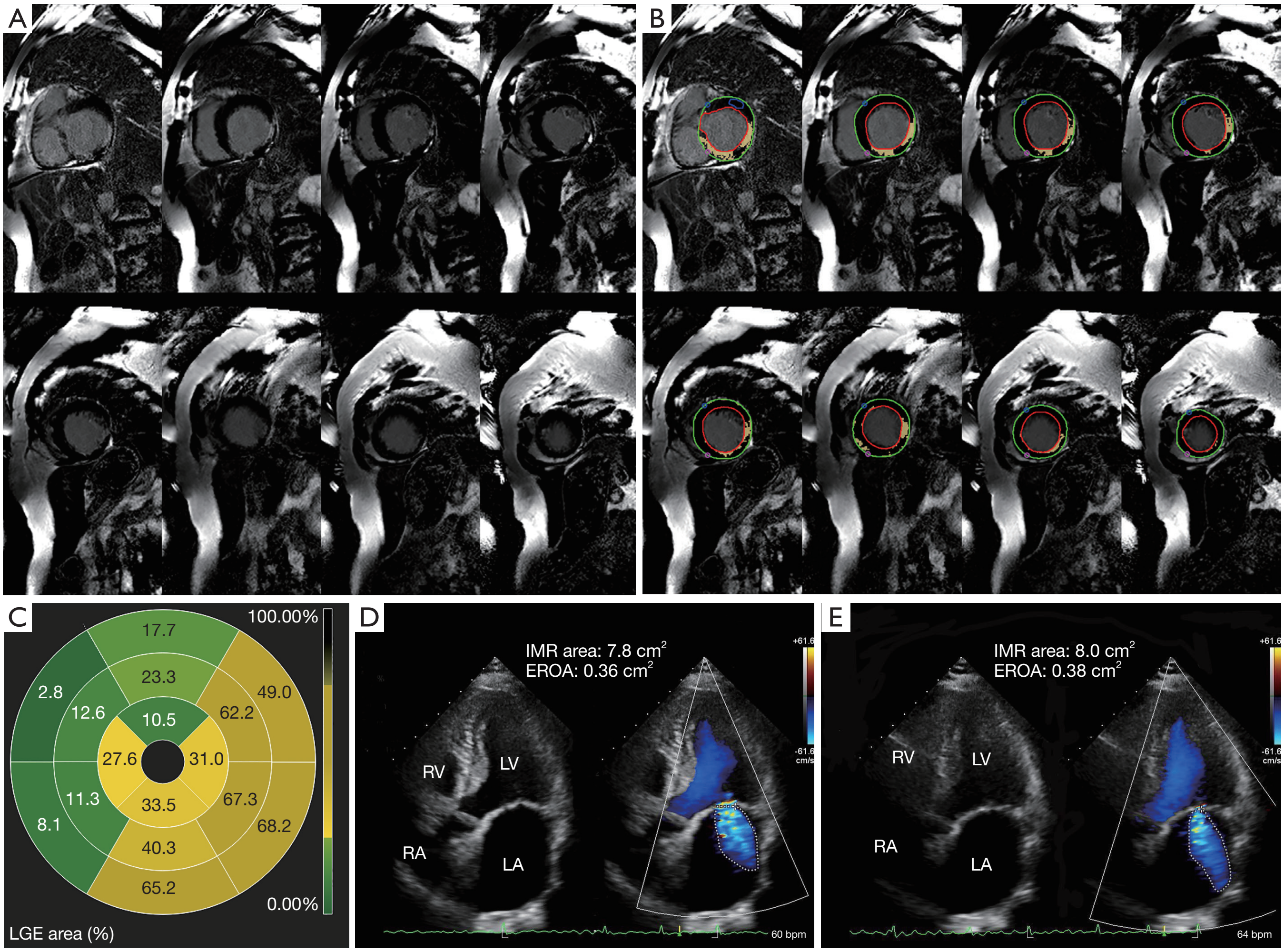

Figure 3 Imaging data of a patient with no IMR improvement. (A) LGE short-axis section of the LV. (B) Contour of the LV endocardium and epicardium sketched using software (green is the epicardium, red is the endocardium); the yellow area is the LGE area. (C) Sixteen-segment diagram of the LV show that MI segments connected to PM is 2. (D) Preoperative echocardiogram results. IMR area in the dashed line was 7.8 cm^2, and EROA was calculated as 0.36 cm^2. (E) The echocardiogram results at 1 year after operation. IMR area in the dashed line was 8.0 cm^2, and EROA was calculated as 0.38 cm^2. LGE, late gadolinium enhancement; IMR, ischemic mitral regurgitation; EROA, effective regurgitation orifice area; RV, right ventricle/ventricular; LV, left ventricle/ventricular; RA, right atrium; LA, left atrium; MI, myocardial infarction; PM, papillary muscle.

or posterior wall infarction, and the main mechanism of IMR is PM displacement in the apical and posterolateral directions, leading to stretching of the chordae tendineae (10). The present study showed that the ratio of LGE mass to overall LV mass was not a risk factor for unimproved IMR, whereas the myocardium connected to PM in the unimproved group contained more MI segments. The improvement in IMR may be due to the reversal of local LV remodeling after revascularization, the improvement in local LV wall motion, and the reduction in chordae tendineae stretching. If the degree of infarction in the myocardium connected to PM is severe, LV local remodeling cannot be reversed after revascularization, and IMR cannot be improved. Therefore, we believe that IMR is mainly caused by local remodeling of the LV, which is consistent with the results of a previous study (4).

Previous studies (4,5) showed that a greater LVEF and a greater posterior-inferior volume ratio are predictors of an improvement in IMR after isolated CABG. Conversely, LV dysfunction (LVEF ≤40%), dyssynchronous movement

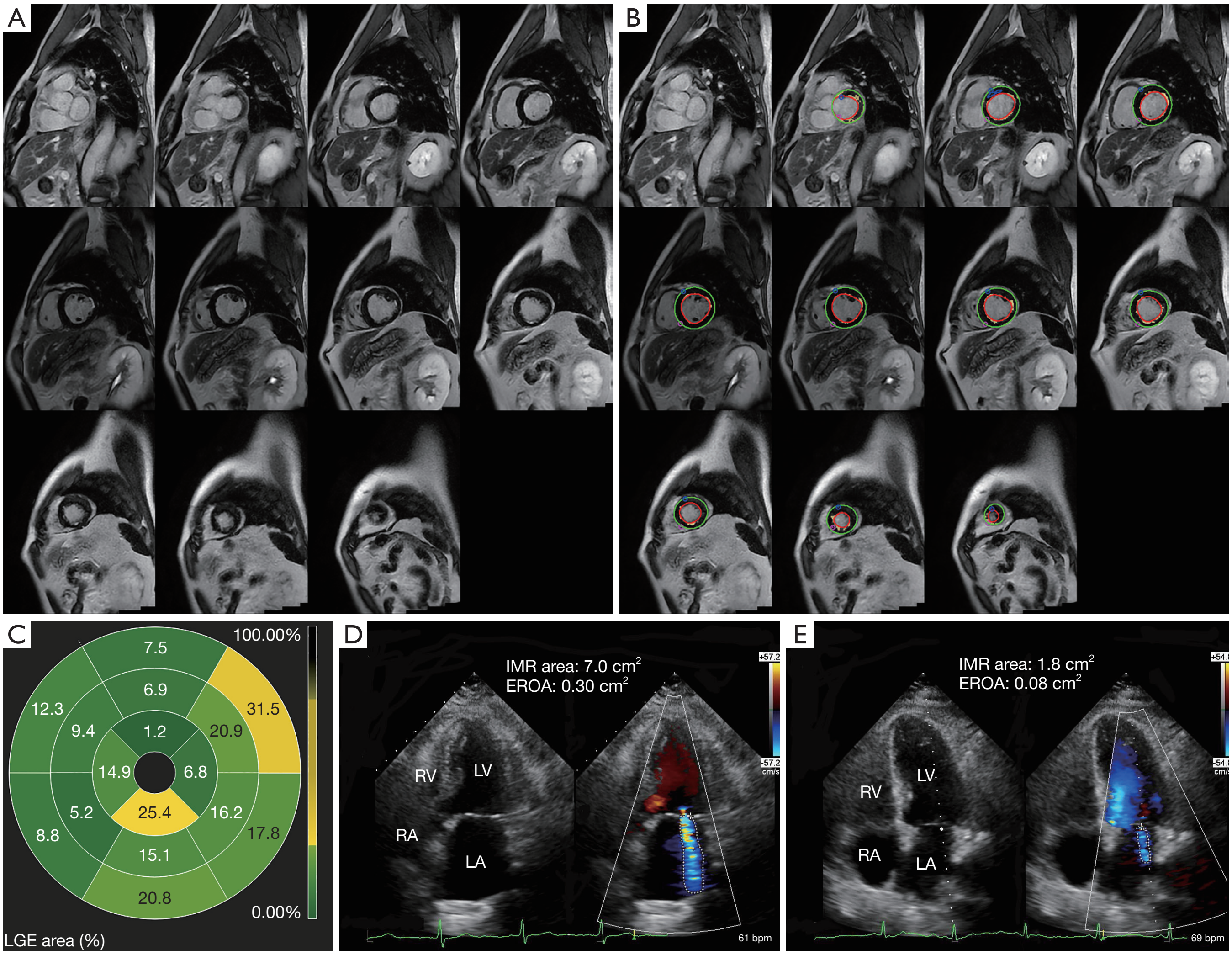

Figure 4 Imaging data of a patient with IMR improvement. (A) LGE short-axis section of the LV. (B) Contour of the LV endocardium and epicardium sketched using software (green is the epicardium, red is the endocardium); the yellow area is the LGE area. (C) Sixteen-segment diagram of the LV shows that MI segments connected to PM is 0. (D) Preoperative echocardiogram results. IMR area in the dashed line was 7.0 cm^2, and EROA was calculated as 0.30 cm^2. (E) The echocardiogram results at 1 year after operation. IMR area in the dashed line was 1.8 cm^2, and EROA was calculated as 0.08 cm^2. LGE, late gadolinium enhancement; IMR, ischemic mitral regurgitation; EROA, effective regurgitation orifice area; RV, right ventricle/ventricular; LV, left ventricle/ventricular; RA, right atrium; LA, left atrium; MI, myocardial infarction; PM, papillary muscle.

between PMs, and abnormal movement of the anterior wall of the LV are risk factors for no IMR improvement after isolated CABG (6-8). The main mechanism of IMR is ventricular remodeling induced by myocardial ischemia, which is closely related to myocardial scarring. Therefore, the degree of myocardial scarring is a key factor in predicting reverse myocardial remodeling and improving IMR after CABG. In this study, the evaluation of the degree and scope of myocardial scarring by LGE showed that the number of MI segments connected to PM was an independent risk factor for no IMR improvement after isolated CABG.

Several studies have revealed whether there is a correlation between IMR and PMI (19,20), showing that IMR is irrelevant to PMI. Similarly, Tanimoto *et al.* (21) concluded that IMR is caused by LV remodeling and that there is no evidence of a link to PMI. The results of the present study suggest that PMI is not associated with IMR

Table 3 Univariate and multivariate analyses

Variable	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P values	OR (95% CI)	P values
LVEF (%)	0.96 (0.91–1.02)	0.157	–	–
LVEDD (mm)	1.00 (0.93–1.07)	0.902	–	–
PMI	1.56 (0.42–5.81)	0.508	–	–
Number of MI segments in global LV	1.61 (1.20–2.16)	0.001	–	–
Number of MI segments connected to PM	4.39 (1.93–9.98)	<0.001	4.39 (1.93–9.98)	<0.001

OR, odds ratio; CI, confidence interval; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; PMI, papillary muscle infarction; MI, myocardial infarction; LV, left ventricular; PM, papillary muscle.

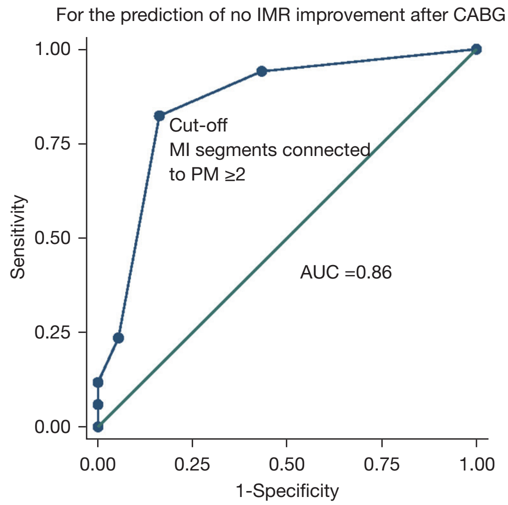

Figure 5 ROC curve analysis. For the prediction of no IMR improvement after isolated CABG, the optimal cut-off value for MI segments connected to PM was 2. IMR, ischemic mitral regurgitation; CABG, coronary artery bypass grafting; MI, myocardial infarction; PM, papillary muscle; AUC, area under the curve; ROC, receiver operating characteristic.

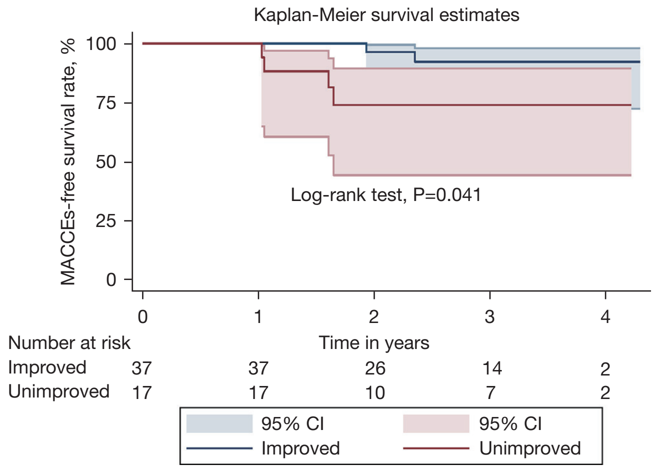

Figure 6 MACCEs-free survival curve plotted using the Kaplan-Meier method (log-rank test, P=0.041). MACCEs, major adverse cardiovascular and cerebrovascular events; CI, confidence interval.

Table 4 A cross-tabulation of preoperative LGE area and 1-year postoperative echocardiography

Preoperative LGE area	1-year postoperative echocardiography		Total
	No IMR improvement	IMR improvement	
No IMR improvement	14	6	20
IMR improvement	3	31	34
Total	17	37	54

LGE, late gadolinium enhancement; IMR, ischemic mitral regurgitation.

improvement after isolated CABG. This is because the mitral valve-chordae tendineae-PM complex still exists after PMI. The function of the PM is not to contract to close the mitral valve, but to ensure that the mitral valve is in the proper position during ventricular contraction so that the mitral valve can be closed.

As described above, this study evaluated the number of MI segments connected to PM by CMR-LGE to predict whether IMR improved after isolated CABG in patients with CHD complicated with moderate IMR. The results showed that the number of MI segments connected to PM was an independent risk factor for no IMR improvement after isolated CABG. The results of this study are helpful to identify patients with improved IMR after isolated CABG, so as to make individualized diagnosis and treatment

Table 5 1-year postoperative echocardiography and follow-up results

Variable	Improved (n=37)	Unimproved (n=17)	P values
Echocardiogram			
LVEF (%)	55.8±9.2	54.2±6.7	0.620
LVEDD (mm)	51.2±5.9	52.5±6.7	0.561
LVESD (mm)	36.2±7.4	38.2±7.1	0.481
IMR area (cm²)	2.3±1.2	6.2±1.7	<0.001
EROA (cm²)	0.12±0.06	0.31±0.09	<0.001
Results follow-up			
MACCEs	2 (5.4)	4 (23.5)	0.041
NYHA classification			0.026
Class I	19 (51.4)	4 (23.5)	
Class II	13 (35.1)	7 (41.2)	
Class III	5 (13.5)	5 (29.4)	
Class IV	0 (0.0)	1 (5.9)	
MI segments connected to PM ≥2	6 (16.2)	14 (82.4)	<0.001

The data are presented as mean ± SD or n (%). LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; IMR, ischemic mitral regurgitation; EROA, effective regurgitation orifice area; MACCEs, major adverse cardiovascular and cerebrovascular events; NYHA, New York Heart Association.

for such patients, reduce the incidence of MACCEs and improve the prognosis.

Limitations of the study

This study had several limitations. Firstly, this was a single-center, retrospective, observational cohort study with a small sample size. Thus, further verification in a multicenter, prospective, large-sample study is required. Secondly, the preoperative cardiac function of selected patients undergoing LGE was poor, which may have resulted in patient selection bias. Thirdly, the follow-up period was short; thus, a longer follow-up period is required to confirm our findings. Finally, because of the long LGE examination time at the postoperative outpatient department, some patients did not undergo postoperative LGE, preventing comparisons of the preoperative and postoperative imaging findings.

Conclusions

For patients with CHD complicated with moderate IMR, LGE can be used to evaluate the number of MI segments connected to PM to guide the choice of surgical strategy. The presence of <2 MI segments connected to PM is associated with an improvement in IMR after isolated CABG. For patients with ≥2 MI segments connected to PM, mitral valve surgery should be performed simultaneously with CABG.

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Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-301/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-301/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Ethics Committee of Beijing Anzhen Hospital (No. 2016024) and informed consent was taken from all the patients.

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