Predictors of moderate ischemic mitral regurgitation improvement after off-pump coronary artery bypass

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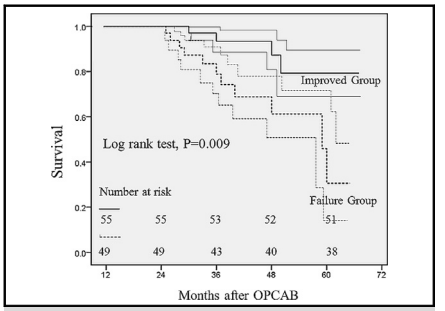
ABSTRACT

Objective: The aim of this study was to explore the predictors of improvement of moderate ischemic mitral regurgitation after off-pump coronary artery bypass grafting.

Methods: A prospective study was performed among 109 patients (aged 66.6 ± 8.6 years, 34.6% were female) with prior myocardial infarction and moderate ischemic mitral regurgitation undergoing off-pump coronary artery bypass grafting. Preoperative and follow-up clinical characteristics and echocardiography data were analyzed, focusing on left ventricular global/regional remodeling and function. Patients were grouped by postoperative ischemic mitral regurgitation at 1 year postoperatively: the improved group with no or mild ischemic mitral regurgitation and the failure group with moderate or severe ischemic mitral regurgitation. Data were compared between the 2 groups to explore the predictors of ischemic mitral regurgitation improvement after off-pump coronary artery bypass grafting.

Results: Five patients died within 1 year and were excluded. At the 1-year follow-up, there were 55 patients in the improved group and 49 patients in the failure group. Before surgery, the improved group had smaller left ventricular end-systolic volume, greater left ventricular ejection fraction, greater posterior-inferior volume ratio, and earlier operation timing after infarction than the failure group. Posterior-inferior volume ratio ($P < .001$), ejection fraction ($P = .003$), and duration between infarction and operation ($P < .001$) were independent predictors of preoperative moderate ischemic mitral regurgitation improvement.

Conclusions: In selected patients, preoperative moderate ischemic mitral regurgitation was relieved by off-pump coronary artery bypass grafting. Greater ejection fraction, greater posterior-inferior volume ratio, and early operation timing after infarction may predict the improvement of moderate ischemic mitral regurgitation after off-pump coronary artery bypass grafting, suggesting that posterior-inferior regional remodeling, reserved ventricular function, and early revascularization are important to the outcome. (J Thorac Cardiovasc Surg 2015;149:1606-12)



Postoperative survival estimates for patients with moderate IMR undergoing OPCAB. *OPCAB*, Off-pump coronary artery bypass.

Central Message

In patients with moderate IMR undergoing OPCAB, greater EF, greater posterior-inferior volume ratio, and early operation timing after infarction may predict postoperative improvement of IMR, suggesting that posterior-inferior regional remodeling, reserved ventricular function, and early revascularization are important to the outcome.

Perspective

To date, identified predictors of IMR improvement after revascularization are scattered, especially in the LV regional remodeling aspect. The present study indicates that for patients with significant posterior-inferior regional remodeling and relatively reserved LV function, early OPCAB would be a benefit for IMR improvement and the outcome. These findings provide a novel perspective in predicting the improvement of IMR. Further studies with a larger sample volume and longer follow-up could establish a rational algorithm, which would combine all these factors with cutoff points and allow optimizing surgical strategies.

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Ischemic mitral regurgitation (IMR) occurs frequently after myocardial infarction (MI) due to left ventricular (LV) global or regional remodeling.[1] So far, the optimal strategy for moderate IMR is still controversial. Some studies had reported that combined mitral valve annuloplasty (MVA) and coronary artery bypass grafting (CABG) could reduce IMR immediately after surgery and at follow-up[2,3]; however, others have shown that recurrent IMR did occur after CABG plus MVA, and no benefit for long-term

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
CI = confidence interval
EF = ejection fraction
IMR = ischemic mitral regurgitation
LV = left ventricular
LVEDV = left ventricular end-diastolic volume
LVEF = left ventricular ejection fraction
LVESV = left ventricular end-systolic volume
MI = myocardial infarction
MR = mitral regurgitation
MVA = mitral valve annuloplasty
NYHA = New York Heart Association
OPCAB = off-pump coronary artery bypass
OR = odds ratio

survival was observed.[4,5] A recent randomized trial showed no greater LV reverse remodeling or clinical advantage of adding MVA to CABG at 1 year.[6] There was also a tendency toward higher complication rates and mortality in CABG plus MVA compared with CABG alone in high-risk patients.[2,6] Therefore, it is of concern whether moderate IMR can be reduced after CABG alone.

To date, identified predictors of IMR improvement after CABG are scattered. Penicka and colleagues[7] recommended the presence of viable myocardium and the absence of dyssynchrony between papillary muscles as predictors for IMR improvement. Braun and colleagues[8] demonstrated that preoperative LV dimension was related to reverse remodeling with IMR changes after CABG plus MVA. Jeong and colleagues[9] and Fattouch and colleagues[10] suggested that in patients with moderate IMR with a left ventricular ejection fraction (LVEF) 40% or less, CABG alone is not recommended because of a high incidence of recurrent mitral regurgitation (MR) and cardiac-related mortality. However, as an important mechanism of IMR, LV regional remodeling is barely studied, and the relationship between regional remodeling and IMR changes after revascularization has not been identified. The aim of this study was to identify the predictors of IMR improvement after off-pump coronary artery bypass (OPCAB) by focusing on regional remodeling.

MATERIALS AND METHODS

Study Population

Between May 2008 and May 2013, 939 patients with left main or proximal 3-vessel disease underwent isolated CABG at Huashan Hospital of Fudan University, including 918 OPCAB cases. All patients with moderate IMR undergoing OPCAB were assessed for study eligibility by checking the following criteria: (1) prior MI by electrocardiogram or regional wall motion abnormalities by echocardiography; (2) structurally normal mitral valve; (3) available echocardiography image quality allowing 3-dimensional quantitative analysis; and (4) sinus rhythm. Patients with clinical and echocardiography evidence of other cardiac structural disease, organic abnormality of the mitral apparatus, atrial fibrillation, and unstable clinical conditions were excluded. A total of 109 patients who were enrolled in the study underwent OPCAB as the only surgical procedure and accepted the same anti-ischemic and heart failure therapies. The study was approved and monitored by the institutional review board of Huashan Hospital. Each patient provided written informed consent before participation in the study. All authors had full access to and take full responsibility for the integrity of the data.

Study Protocol

At Huashan Hospital of Fudan University, patients with moderate IMR or less underwent OPCAB unless it was combined with aorta or aortic valvular lesions, whereas those with severe IMR underwent CABG and MVA. For patients with moderate IMR, preoperative clinical characteristics and echocardiography data were collected. Patients were followed up clinically and by echocardiography regularly and were grouped according to postoperative changes of IMR at 1 year after surgery: the improved group with no or mild IMR and the failure group with moderate or severe IMR. Preoperative and postoperative data were compared between the 2 groups, and predictors of IMR improvement were explored. Clinical data and 2-dimensional and 3-dimensional echocardiography were separately studied in a blind manner by 3 researchers to avoid selection bias.

Preoperative Echocardiography

Two-dimensional echocardiography. Preoperative echocardiography was performed 1 week before surgery. All patients underwent standard transthoracic echocardiogram with the Philips IE 33 system (S5-1 probe, 2.5-5.5 MHz; Philips Healthcare, Andover, Mass). MR severity was evaluated by measuring the ratio of MR color flow jet area to the left atrium area using color mapping of the apical 4-chamber view during cardiac systole, graded as mild (<20%), moderate (20%-40%), or severe (>40%).[11] Moderate MR was further verified by the width of the vena contracta (0.3-0.7 cm). The tenting area, mitral annular area,[12] displacement of papillary muscles, and sphericity index were measured.

Real time 3-dimensional echocardiography. By using the X 3-1 probe, datasets of each subject were stored and analyzed by QLAB 3D-Advanced Quantification software (Philips Healthcare). The software traced the endocardium border during the whole cardiac cycle and calculated the LV volume and regional volumes of 17 segments, gaining global and regional volume and function, such as the left ventricular end-diastolic volume (LVEDV), left ventricular end-systolic volume (LVESV), LVEF, volume, and EF of the posterior-inferior 5 segments (basal, mid, apical inferior segments and basal, mid inferolateral segments). The ratio of regional segments volume to LVEDV was calculated. All echocardiography parameters were standardized by body surface area.

Surgical Procedures

All surgical procedures were performed through a midline sternotomy. The left internal thoracic arteries were harvested and grafted to the left anterior descending coronary arteries in patients aged less than 75 years. Saphenous vein grafts and radial arteries (in patients aged <60 years) were harvested, and sequential aorto-coronary bypass grafting was performed in the remaining coronary arteries. Starfish and Octopus (Medtronic Inc, Minneapolis, Minn) devices were used in all cases. Proximal silastic snare sutures and carbon dioxide blowers were used to obtain a bloodless field. Intraluminal shunts were used during grafting. The left internal thoracic artery to left anterior descending anastomoses were performed with 7-0 Prolene sutures, and other anastomoses were performed with 6-0 Prolene sutures. Complete revascularization was performed in all cases regardless of the number or quality of lesion vessels.