Original Article

Prognostic Value of Left Ventricular Myocardial Performance Index in Patients Undergoing Coronary Artery Bypass Graft Surgery

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Background: Left ventricular myocardial performance index is a Doppler-derived parameter of nongeometrical ventricular function that measures both systolic and diastolic function of the left ventricle. The objective of this study was to compare prognostic value of left ventricular myocardial performance index with global left ventricle function in patients undergoing coronary artery bypass graft surgery.

Methods: One hundred consecutive patients who underwent coronary artery bypass graft surgery for coronary artery disease were studied from March 2004 through September 2006. Recovery of global left ventricle function and left ventricular myocardial performance index were measured serially by Doppler echocardiography after coronary artery bypass graft surgery. The patients were under supervision for four months after discharging from hospital. We studied the incidence of atrial fibrillation, postoperative myocardial infarction, pericardial and pleural effusion, infection, and also ventilation time and intensive care unit stay. For analysis of the events, we divided the patients into two groups. Group A was considered with left ventricle ejection fraction of <40% and group B had a left ventricle ejection fraction of >40%.

Results: Global left ventricle ejection fraction and left ventricular myocardial performance index were not related to pericardial effusion, pleural effusion, and postoperative infection. In group A, left ventricular myocardial performance index had more prognostic value for prediction of incidence of atrial fibrillation rhythm and postoperative myocardial infarction than the global left ventricle ejection fraction. But global left ventricle ejection fraction had more prognostic value for ventilation time and intensive care unit stay in comparison with left ventricular myocardial performance index. These associations were not seen in group B.

Conclusion: The prognostic effect of left ventricular myocardial performance index was no more than global left ventricle ejection fraction in early and late complications of coronary artery bypass graft surgery but only affirm global left ventricle ejection fraction in some situations.

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Keywords: Coronary artery bypass graft surgery • myocardial performance index

Introduction

The postsurgical morbidity and mortality of coronary artery bypass graft surgery (CABG) is the most important factor that should be evaluated before the surgery. The presence of left ventricular (LV) dysfunction in pre- and postoperative period is one of the most important independent predictors for surgical mortality and morbidity.

The myocardial performance index (MPI) is reported to be useful for evaluating the prognosis after acute myocardial infarction (MI). In 1995, Tei and colleagues proposed a Doppler-derived time interval index, the so-called left ventricular myocardial performance index (LVMPI) which is defined as the sum of the isovolumic contraction time (IVCT) and relaxation time (IVRT) divided by the ejection time (ET) (Equation 1).

$$LVMPI = \frac{IVCT + IVRT}{ET} \quad \textit{Equation 1}$$

This index is independent from LV geometry

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and heart rate. MPI and more specifically LVMPI can be easily obtained and reproduced regardless of LV geometry which makes it adequate for the assessment of the overall ventricular function in several clinical situations. Global LV function is evaluated by modified Simpson's method.

The objective of this study was to compare the prognostic value of LVMPI with global LV ejection fraction (EF) in patients undergoing CABG.

Patients and Methods

Out of 136 consecutive patients, 100 patients (78 men and 22 women) were found eligible and studied. The selected patients were those who had coronary artery disease with no significant valvular disorders. All patients were informed completely about the study.

Echocardiographic data were collected three times—before, one, and four months after the surgery. Two-dimensional and Doppler echocardiography were performed on a Megas-Esaote echocardiography unit with 3.5 MHz electronic probe. For assessment of each parameter, five consecutive beats were measured and averaged. Doppler time intervals were measured from the mitral flow and LV outflow velocity time intervals (Figure 1). The LVMPI was calculated according to the Equation 1. Global LV systolic function was assessed by calculating the EF which was measured by determining LV volumes from apical four- and two-chamber views using modified Simpson's method.

Statistical analysis

This cohort study was consisted of patients who had a complete follow-up with an analyzable four-month follow-up echocardiography. Continuous variables were expressed as mean±SD. The mean of normally-distribute variables was compared by two-tailed Student's *t*-test for paired or unpaired data, as appropriate. For comparison of more than two independent groups of data, one-way analysis of variance (ANOVA), and for comparison of repeated measures ANOVA for repeated measures were used. The categorical variables were compared by χ^2 and Fisher's exact test. A $P<0.05$ was considered statistically significant.

Results

The age of 100 patients participated in this study ranged from 37 to 73 years. All surgeries were elective. The patients were divided into two groups based on their LV EF—more than 40% in group A, and <40% in group B. The characteristics of these groups are shown in Table 1 and Figure 2.

In this study, there was no mortality, mediastinitis, or cerebrovascular accident. Minor complications were observed in 66% of the patients. The incidence of minor complications in group A was 41% and in group B was 25%. The overall incidence of minor complications was 15% for atrial fibrillation (AF); 6% for silent and small MI (i.e., only enzyme rising without any significant ECG changes); 7% for sternal wound infection; 8% for pericardial effusion; 30% for pleural effusion; and 22% for readmission (Figure 2).

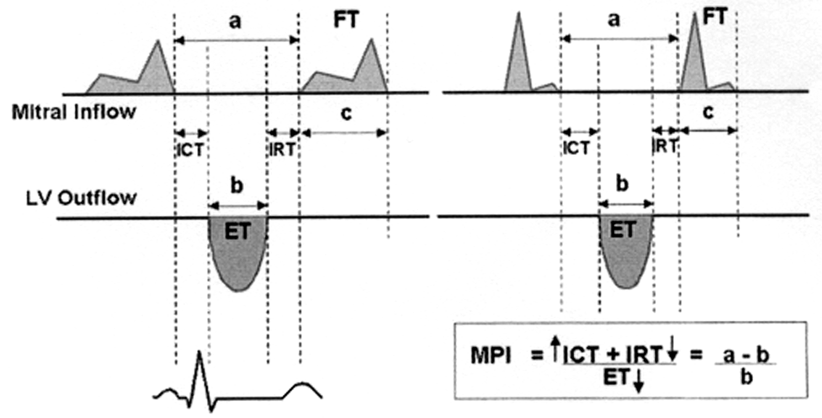

Figure 1. Derivation of the LVMPI from Doppler tracings of mitral inflow and LV outflow. a=time between filling periods, which equals the duration of mitral regurgitation (MR), when present; b=ejection time (ET); c=filling time (FT). The sum of isovolumic contraction time (ICT) and isovolumic relaxation time (IRT) can be obtained by the subtraction of b from a.

Table 1. Mean LV EF(0) and LVMPI(0) in both groups with different complications.

Complications		Group A				Group B			
		LV EF(0)		LVMPI(0)		LV EF(0)		LVMPI(0)	
		P value	Mean	*P* value	Mean	*P* value	Mean	*P* value	Mean
AF									
	Yes	0.226	0.37	0.003	0.62	0.506	0.50	0.120	0.52
	No		0.38		0.57		0.48		0.55
MI									
	Yes	0.248	0.36	0.450	0.53	—	0.45	—	0.58
	No		0.38		0.58		0.49		0.54
Pericardial effusion									
	Yes	0.027	0.35	0.219	0.61	0.853	0.48	0.400	0.59
	No		0.38		0.57		0.49		0.54
Pleural effusion									
	Yes	0.887	0.38	0.857	0.58	0.329	0.49	0.553	0.54
	No		0.38		0.58		0.48		0.55
Infection									
	Yes	0.358	0.38	0.230	0.60	0.798	0.46	0.304	0.50
	No		0.38		0.57		0.49		0.55
Readmission									
	Yes	0.410	0.37	0.100	0.59	0.603	0.48	0.130	0.54
	No		0.38		0.57		0.49		0.55

AF= atrial fibrillation; MI=myocardial infarction.

In group B (EF<4%), LV EF and LVMPI in both genders and all groups of risk factors were equal during all phases of the study.

In group A (EF>40%), ΔLV EF (the difference of pre- and four months postoperative LVEF) was more in women than men (*P*=0.03) whereas ΔLVMPI (the difference of pre- and four months postoperative LVMPI) was more in women than men (*P*=0.01). ΔLV EF was not different in diabetic and nondiabetic patients whereas ΔLVMPI in nondiabetics was more than diabetics (*P*=0.084). ΔLV EF and ΔLVMPI in patients who had high LDL were more than those who did not have it. This result was not observed in patients with hypertriglyceridemia. LV EF and LVMPI among hypertensive and normotensive patients, smokers and nonsmokers, with positive and negative family history of premature coronary artery disease, and history of acute coronary syndrome before surgery and without it, did not have any significant statistical difference during all phases of the study.

In group B, LV EF and LVMPI were not significantly different between the patients who had AF and those who did not have it. In group A, no significant correlation was observed between the pre- and postoperative LV EF and the incidence of developing AF, however, postoperative LV EF in patients who developed postoperative AF, showed less increment than those who did not have it (*P*=0.002). Meanwhile, pre- and postoperative LVMPI in patients who had AF rhythm was significantly more than that in those without AF (*P*=0.003). ΔLVMPI was also higher in this group (*P*=0.005).

In group A patients who had postoperative MI, the preoperative LV EF had no effect on the incidence of MI. In the same patients, however, one- month postoperative LV EF decreased significantly in those patients who had MI (*P*<0.001); this decrement was improved four months after the surgery. In group B who

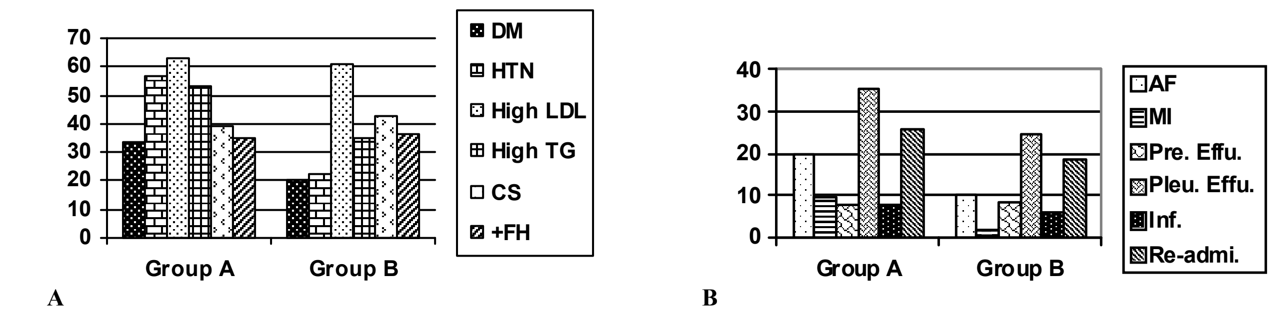

Figure 2. Frequency of A) risk factors and B) complications.

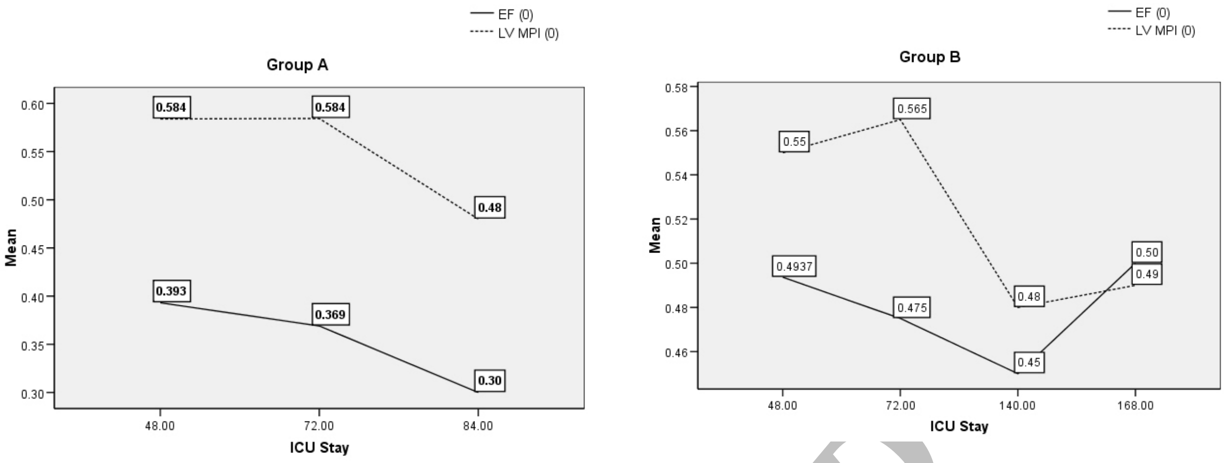

Figure 3. Correlation between preoperative LV EF and LVMPI and ICU stay.

developed MI, the average increment of LV EF was 5%, while in group A patients who developed MI, this value was 2.7%. In group A, preoperative LVMPI had no effect on the incidence of postoperative MI, but in patients with MI, the improvement of LVMPI (ΔLVMPI) was clearly less than those without MI (P=0.002). In group B, the number of patients who had MI was not enough for analysis.

In group B, in patients who had postoperative pericardial effusion, LV EF and LVMPI did not show any significant difference during all phases of the study, but in group A, preoperative LV EF was less in patients with pericardial effusion (P=0.027). Preoperative LVMPI was the same in both groups but one- month postoperative LVMPI was significantly higher in this group.

In patients who had pleural effusion or post-operative infection, no significant difference was observed between LV EF and LVMPI during all phases of the study.

In group A, patients with less global LV EF had more ICU stay duration (P<0.001), but there was no correlation between LVMPI and ICU stay (Figure 3). In group B, these correlations were not seen.

In group B, those who had longer ventilation time, one-month postoperative had a significantly (P=0.003) lower LV EF, but this difference eventually vanished four months postoperative. In group A, the aforementioned patients had significantly lower preoperative LV EF (P=0.001) which remained after one month postoperative (P=0.014) (Figure 4).

Discussion

CABG is a major procedure frequently performed round the globe and its complications are related to preoperative conditions. The prognostic evaluation of the patients undergoing CABG through preoperative clinical parameters, present

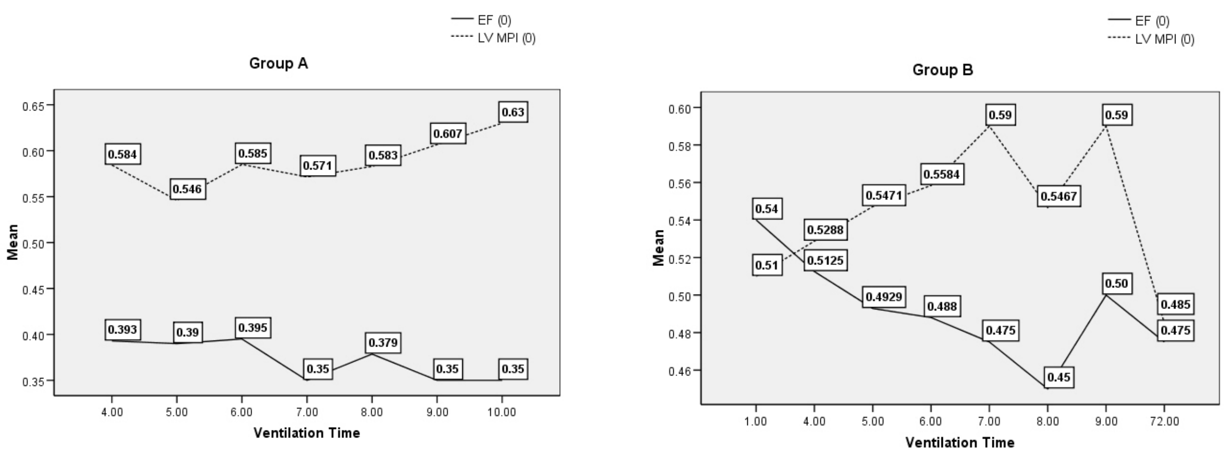

Figure 4. Correlation between preoperative LV EF and LVMPI and ventilation time.

well-defined usefulness and understanding.

The use of a single index to quantify global LV function may simplify the evaluation of cardiac surgical patient. It has been suggested that LVMPI may have an important role as an adjunct to conventional echocardiographic variables in patient after CABG.[1] LVMPI is independent to heart rate, blood pressure, and ventricular geometry.[2] It provides prognostic information in patients with recent MI[3] or congestive heart failure.[4] But no link was shown between LVMPI and immediate cardiovascular complications.[5] The study by Murphy et al. on patients who underwent CABG showed that LVMPI correlates well with standard echocardiographic measures of systolic function and correlates modestly well with the overall diastolic heart function just in intra-operative period.[6] The objective of this study was to evaluate the LVMPI as a predictor of adverse events in early and late period after CABG.

In this study, we divided the patients into two groups according to their LV EF (group A: EF >40%, group B: EF<40%). LV EF was able to predict some complications in one group and LVMPI in another.

Regarding postoperative AF rhythm in group B, there was no correlation between LV EF, LVMPI, and occurrence of AF; also AF rhythm had no adverse effect on the prognosis. In group A, the incidence of postoperative AF was more than group B and improvement of myocardial function was significantly less than group B patients. On the other hand, pre- and postoperative LVMPI and its improvement were more in group A which was probably due to lower LV EF and hence more benefit from revascularization in this group. Overall, lower LV EF and higher LVMPI lead to an increase in the incidence of AF in group A.

Regarding postoperative MI, no correlation was seen between LVMPI, LV EF, and incidence of MI in both groups. One-month postoperative LV EF was lower than preoperative LV EF in those who developed MI but this index was increased after four months of surgery. In patients with MI in group A, improvement of LV EF and LVMPI was less than in those in group B, which means that in group A, postoperative MI can lead to delay of improvement in LV EF and LVMPI.

In those who developed postoperative pericardial effusion, the preoperative LV EF was lower than others who did not in both groups. However, there was no significant difference in LVMPI. Pericardial effusion had no adverse effect on late diastolic and systolic function as a result of temporary increase in one-month postoperative LVMPI.

LV EF and LVMPI were not considered as prognostic factors for developing pleural effusion and sternal wound infection.

LVMPI had no effect on ventilation time and ICU stay, but in group A, lower LV EF led to longer ventilation time and ICU stay.

In summary, the prognostic effect of LVMPI was no more than global LV EF in early and late complications of CABG but only affirm global LV EF in some situations.

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