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Coronary: Short Report

Does Cardiac Function Improvement With Coronary Artery Bypass Grafting Reduce All-Cause Mortality?

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ABSTRACT

BACKGROUND The effect of coronary artery bypass grafting (CABG) on cardiac function improvement remains controversial. Furthermore, recent evidence suggests that improvement in cardiac function after CABG does not improve life expectancy. This study aimed to examine whether CABG improved cardiac function and how this improvement influenced all-cause mortality and to compare patient prognosis according to preoperative cardiac function.

METHODS This retrospective study included patients with a left ventricular ejection fraction (LVEF) of ≤35% who underwent CABG between January 1994 and December 2022. We compared patients with and without cardiac function improvement, defined as an increase in LVEF of ≥10%, to identify associated factors and assess the impact on all-cause mortality. We also compared outcomes according to the degree of preoperative LV dysfunction.

RESULTS Among the 166 patients included, 102 and 64 had a preoperative LVEF of 25%-35% and ≤25%, respectively. The mean follow-up duration was 79.9 ± 72.3 months. We observed significant LVEF improvement, from 28% (range, 23.3%-35%) preoperatively to 39% (range, 31%-46%) at 13.1 months postoperatively. The 7-year survival rates were similar in the ejection fraction ≤25% and 25%-35% groups (80.2% vs 73.8%, $P = .11$). However, patients with an LVEF improvement of ≥10% exhibited a markedly better prognosis than those without LVEF improvement at 7 years (85.9% vs 63.5%, $P = .001$).

CONCLUSIONS Our findings suggest that CABG may enhance cardiac function in more than half of patients with ischemic cardiomyopathy, with a correlation to improved all-cause mortality. Moreover, LVEF improvement after CABG is associated with an improved prognosis.

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Despite the controversies regarding the necessity of invasive therapies for managing stable angina pectoris, the clinical significance of coronary artery bypass grafting (CABG) remains firmly established, particularly in patients with ischemic cardiomyopathy. The pivotal Comparison of Surgical and Medical Treatment for Congestive Heart Failure and Coronary Artery Disease (STICH/STICHES) study has underscored the prognostic merits of CABG,[1] warranting its class 1 recommendation in clinical guidelines. The rationale behind the observed prognostic benefits of CABG encompasses several factors, namely,

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amelioration of angina pectoris, prevention of myocardial infarction, and enhancement of cardiac function.

However, whether CABG improves cardiac function remains a matter of debate. Although many retrospective studies have reported cardiac function improvement following CABG, a subanalysis of the STICH trial showed no improvement in cardiac function compared with medical therapy[2] or any improvement in patient prognosis due to improved cardiac function. In addition, although the definition of ischemic heart disease is widely based on a left ventricular ejection fraction (LVEF) of ≤35%, data on the prognosis and postoperative cardiac function in patients with severe left ventricular (LV) dysfunction (LVEF <25%) are limited.

In the present study, we investigated the changes in cardiac function after CABG in patients with LVEF <35% and examined whether cardiac function improvement influenced patient prognosis. We also compared patient outcomes after CABG between those with poor (LVEF <25%) and those with relatively good (LVEF 25%-35%) preoperative cardiac function.

IN SHORT

- CABG yields postoperative improvements in LVEF, particularly in severe ischemic cardiomyopathy cases.
- Patients with an LVEF improvement of ≥10% post-CABG demonstrate better overall survival rates, emphasizing the prognostic importance of enhanced cardiac function.
- Survival outcomes remain similar across LVEF groups (LVEF <25% and 25%–35%), suggesting CABG's therapeutic potential in severely ill patients.

PATIENTS AND METHODS

STUDY DESIGN AND POPULATION. We retrospectively reviewed the records of all patients who underwent CABG at Mitsui Memorial Hospital between January 1994 and December 2022. Patients with a preoperative LVEF ≤35% were included in the study. Patients who underwent emergency surgery were excluded. The data were collected through chart review and telephone interviews.

LVEF was evaluated using the modified Simpson method. Postoperative echocardiography findings were based on the most recent available information. Cardiac function improvement was defined as an increase in LVEF by ≥10% compared with the preoperative value.

OUTCOMES. The primary outcome of this study was all-cause mortality, and the secondary outcome was cardiac function improvement.

STATISTICAL ANALYSES. Continuous data are summarized as median value with interquartile range or mean value with SD according to their distribution and were compared using the Mann-Whitney U test. Categorical data are summarized as frequency with percentage and compared using Fisher's exact test. Data normality was assessed using the Shapiro-Wilk test. Pre- and postoperative cardiac function was compared using the Wilcoxon signed-rank test.

Overall mortality rates were estimated using Kaplan-Meier analysis and compared using the log-rank test. Potential prognostic variables that demonstrated significance in the univariable analysis were subsequently included in the multivariable model.

All analyses were conducted using EZR software (Jichi Medical University Saitama Medical Center). Two-tailed P values <.05 were deemed to indicate statistically significant differences.

RESULTS

PATIENT CHARACTERISTICS. During the study period, a total of 2265 patients underwent CABG. After excluding emergency cases, 166 patients with a preoperative LVEF ≤35% were included in our analysis. Postoperative LVEF was assessed at a mean of 13.1 months after the procedure. In the whole cohort, LVEF significantly improved after CABG, from 28% (range, 23.3%-35%) preoperatively to 39% (range, 31%-46%) postoperatively (P < .001; Figure 1).

EFFECT OF CABG ON CARDIAC FUNCTION IMPROVEMENT. Among the 166 patients, postoperative improvement in LVEF of ≥10% was observed in 89 (53.6%) patients. The patients' characteristics according to postoperative cardiac function improvement are summarized in Supplemental Table 1.

Compared with the group without LVEF improvement, the group with improved LVEF had a higher proportion of female patients (13 of 89 [14.6%] vs 2 of 77 [2.6%]; P < .01), lower proportion of patients with a history of prior percutaneous coronary intervention (PCI) (13 of 89 [14.6%] vs 26 of 77 [33.8%]; P < .01), and slightly

lower preoperative LVEF values (26% [range, 22%-31%] vs 29% [range, 24%-31%]; $P = .026$). No significant differences were observed for any other evaluated variable, including operative details, such as number of grafts and use of cardiopulmonary bypass.

In the multivariable analysis, a history of PCI was a negative predictor of improved LVEF. In addition, cardiac function tended to improve in patients with a preoperative LVEF ≤25%, but the difference was not statistically significant (Supplemental Table 2).

EFFECT OF CARDIAC FUNCTION IMPROVEMENT ON SURVIVAL OUTCOMES. The mean follow-up duration from the time of CABG was 6.7 ± 6.0 years (79.9 ± 72.3 months). The 7-year overall survival was 85.9% (95% CI, 75.1%-92.2%) in the group with improved LVEF and 63.5% (95% CI, 49.0%-74.9%) in the group without improved LVEF ($P < .01$; Figure 2).

COMPARISON OF SURVIVAL OUTCOMES ACCORDING TO PREOPERATIVE LVEF. The characteristics of patients according to the preoperative LVEF values showed no significant differences for any of the evaluated variables between patients with a preoperative LVEF <25% and those with an LVEF 25%-35% (Supplemental Table 3). Furthermore, overall survival curves were comparable between the 2 groups, with a 7-year overall survival of 80.2% (95% CI, 64.3%-89.5%) in the ejection fraction <25% group and 73.8% (95% CI, 62.8%-82.0%) in the ejection fraction 25%-35% group (Figure 3).

In the multivariable analysis, LVEF improvement was identified as an independent predictor of all-cause mortality (hazard ratio, 0.52; 95% CI, 0.31-0.86; $P < .05$; Supplemental Table 4).

COMMENT

This study showed that LVEF improved by ≥10% after CABG in more than half of the patients. Notably, patients with an LVEF improvement of ≥10% had significantly better outcomes than those without LVEF improvement. We also observed that patients with poor (LVEF <25%) and those with relatively good (LVEF 25%-35%) preoperative cardiac function had similar survival outcomes.

We observed a substantial increase in LVEF after CABG, from 28% to 39%. Moreover, 53.6% of patients showed an LVEF improvement of ≥10%. In contrast, in the STICH trial, postoperative LVEF measured at 4 months post-randomization showed only modest improvement from baseline (2.29 ± 0.56) in patients with myocardial viability.[2] However, Perry and associates[3] reanalyzed the STICH dataset, focusing on patients who underwent echocardiographic assessment at baseline and 24 months. Although the difference was not statistically significant, 19% of patients receiving medical therapy alongside CABG exhibited an LVEF improvement of >10%, compared with 16% of patients

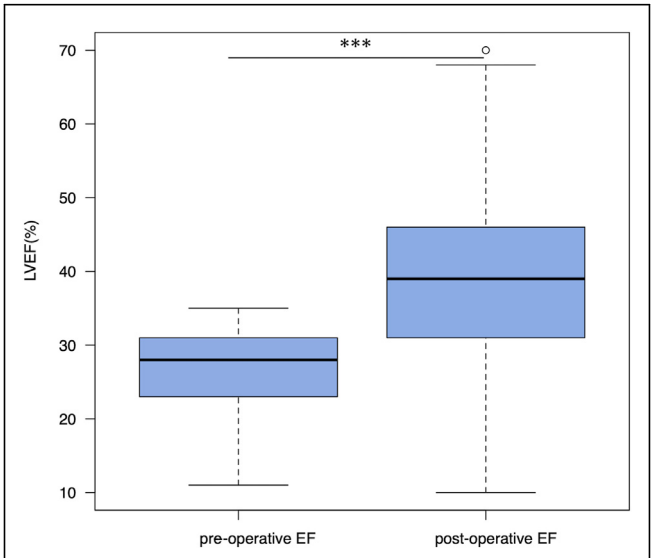

FIGURE 1 Preoperative and postoperative left ventricular ejection fraction (LVEF). (EF, ejection fraction.)

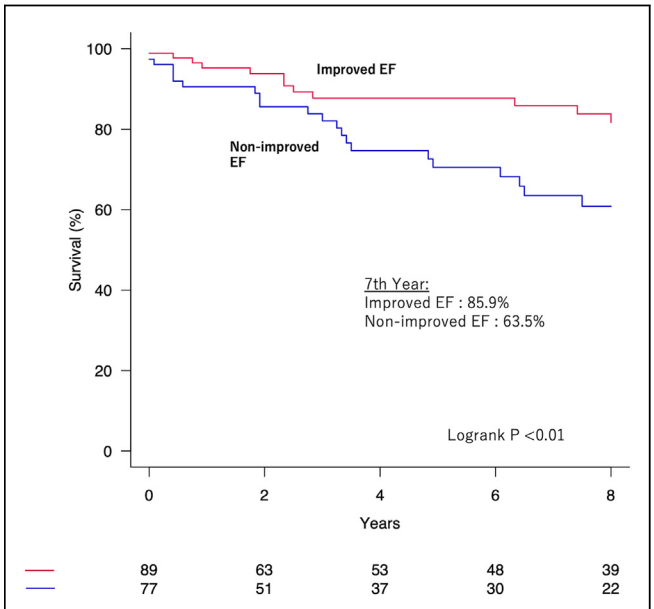

FIGURE 2 Overall survival curves according to the presence or absence of left ventricular ejection fraction (EF) improvement after coronary artery bypass grafting.

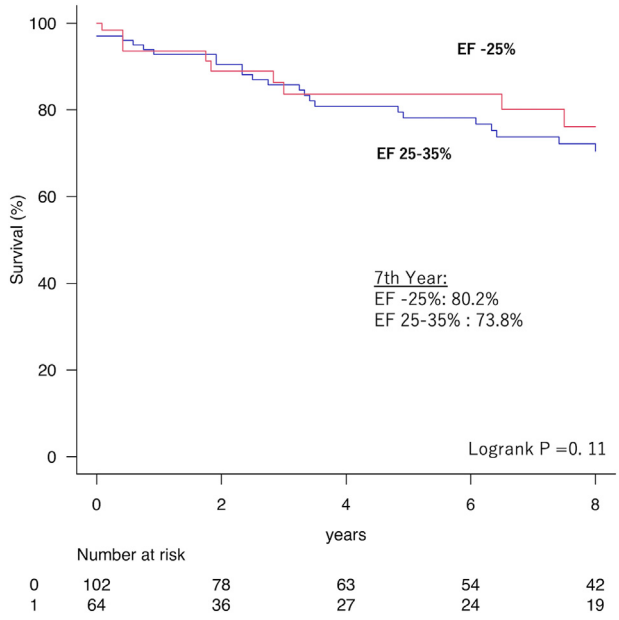

FIGURE 3 Overall survival curves according to the preoperative left ventricular ejection fraction (EF).

assigned to medical therapy alone.[3] This discrepancy may be attributed to the timing of echocardiography, as some patients continued to exhibit gradual improvement in cardiac function over several years. In our study, postoperative LVEF evaluation was based on data obtained at about 13.1 months after surgery. Several retrospective studies have also reported LVEF improvement after CABG,[4,5] with increases ranging from 5%-10% several months to years after CABG. Therefore, a similar amount of time is needed to validate the effect of CABG on cardiac function.

Our findings also suggest a potential connection between improved cardiac function and extended life expectancy. We observed a notable difference in survival rates between patients with and those without LVEF improvement (85.9% vs 65.9% at 7 years), suggesting that enhancing cardiac function could contribute to improved longevity. This finding differs from that of Panza and colleagues,[2] who reported no significant differences in mortality between patients with and without LVEF improvement. Similarly, Samady and coworkers[6] reported no significant difference in outcomes between the EF improvement and non-improvement groups at a mean follow-up of 32 ± 23 months. However, Perry and colleagues[3] identified an independent association between an LVEF improvement of >10% and randomization to CABG and reduced late mortality. Jose and associates[5] also found that the lack of improvement in LV function strongly predicted late mortality. In our analysis, cardiac function improvement was defined as an LVEF increase of ≥10%, and at the 3-year mark, the Kaplan-Meier curves displayed overlapping trends. This suggests that the observed differences in survival prognosis may not have reached statistical significance due to the relatively short follow-up period. Significant differences in prognosis may only emerge with substantial cardiac function improvement, such as an increase in LVEF of ≥10%.

When exploring potential factors influencing LVEF improvement, we found greater LVEF improvements in the group with LVEF <25%. In addition, a history of PCI emerged as a factor negatively affecting cardiac function improvement. Perry and coworkers[3] also identified independent predictors of an LVEF improvement of >10%, including prior myocardial infarction and lower baseline LVEF. Koene and associates[7] reported that patients with improved LVEF less often had diabetes and lower preoperative LVEF, as well as larger LV dimensions at baseline.

Notably, we did not observe a significant difference in mortality rates based on the presence or history of previous PCI. This finding aligns with the results of a prior meta-analysis,[8] which similarly did not reveal a significant impact of prior PCI on mortality outcomes.

In this study, there were many patients with poor preoperative cardiac function with an LVEF below 25%. However, the survival curves were similar between the LVEF <25% and LVEF 25%-35% groups. Studies on CABG in patients with an LVEF below 25% are limited. Iribarne and coworkers[9] compared PCI and CABG and reported that CABG is more advantageous than PCI both for LVEF between 25% and 35% and LVEF below 25%. The results of our study also showed that CABG had comparable midterm outcomes in the LVEF <25% and LVEF 25%-35% groups. Moreover, greater improvements in LVEF were observed in the group with an LVEF below 25%. In the past, operative mortality was higher in patients with a lower LVEF, but this difference is thought to be decreasing due to technological advances. Given that the postoperative improvement in cardiac function was greater in patients with an LVEF of ≤25% and that the life expectancy

did not differ from that of patients with an LVEF of 25%-35%, the therapeutic effect of CABG may be greater in more severely ill patients with an LVEF of ≤25%. This is consistent with the findings of previous studies showing that the more severe the disease, the greater the prognostic benefit of CABG.[10]

This study has some limitations. Its retrospective design may have introduced biases and confounding factors. Hence, prospective, randomized controlled trials are necessary to validate our findings. We have no data on the viability of CABG because we do not evaluate it preoperatively.

In conclusion, LVEF improvement after CABG is associated with improved prognosis. Patients with different degrees of LV dysfunction have similar prognoses; however, the effect of LVEF improvement is greater in patients with a preoperative LVEF of ≤25%.

This study conformed with the principles set forth in the Declaration of Helsinki and was approved by the Institutional Review Board of Mitsui Memorial Hospital on January 30, 2024 (Approval number: 84). The requirement for obtaining informed consent was waived due to the retrospective study design.

The Supplemental Tables can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2024.05.013] on http://www.annalsthoracicsurgery.org.

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