Original Article

A Comparison of Success Rate in Off-Pump Coronary Artery Bypass Grafting Surgery among Patients with Varying Preoperative Left Ventricular Ejection Fractions: Retrospective Observational Study

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Background: Off-pump coronary artery bypass grafting (OPCAB) is an alternative to coronary artery revascularization and avoids the complications of cardiopulmonary bypass (CPB). The procedure's success, however, depends on intraoperative hemodynamic stability. Preoperative cardiac function can predict the tolerance to compromised hemodynamics during cardiac surgery. Inability to manage hypotension and low cardiac output while manipulating the heart is the most frequent cause of intraoperative conversion to CPB.

Objective: The authors investigated the effects of the preoperative left ventricular ejection fraction (LVEF) on the success of OPCAB surgery and the relation of intraoperative factors to the success of OPCAB surgery.

Material and Methods: Medical records of 284 patients who underwent OPCAB surgery in Ramathibodi Hospital between January 2015 and December 2017 were retrospectively reviewed. Preoperatively, the patients were classified into groups 1 to 4 based on LVEFs of 50% to 70%, 40% to 49%, 30% to 39%, and <30%, respectively. Preoperative characteristics were collected. Intraoperative success of OPCAB surgery, application of inotropes, vasopressor, fluid, and intra-aortic balloon pump (IABP), and post-operative outcomes were analyzed and compared among the four LVEF groups.

Results: No significant differences in success of OPCAB surgery emerged among the four groups (p=0.430). Intraoperative requirements of IABP were significantly higher for LVEF <30% patients (p=0.001). In addition, the time to extubation was significantly delayed (p=0.001) and the LVEF <30% patients stayed longer in intensive care unit (ICU) (p=0.002) when compared with the good LVEF patients. There were no significant differences in the operative time, amount of intravenous fluid, blood transfusion requirement, or blood loss among the groups. There were no significant differences in major postoperative morbidities.

Conclusion: OPCAB surgery can be performed successfully in patients with severe cardiac dysfunction (LVEF <30%) without significant differences from LVEF ≥30% patients, although the need for an intraoperative IABP device and inotropic drugs for hemodynamic support were greater and the extubation times and ICU stays were longer.

Keywords: Coronary artery bypass graft; Left ventricular ejection fraction; Off-pump CABG; OPCAB; Poor cardiac function

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Off-pump coronary artery bypass (OPCAB) surgery has been increasingly adopted in an effort to prevent the deleterious effects of cardiopulmonary bypass (CPB) and the cardioplegic solution. Manipulation of the heart and use of the heart stabilizer during OPCAB surgery further compromise the hemodynamic stability of the patient with depressed left ventricular function. Inability to manage hypotension and low cardiac output associated with cardiac manipulation and myocardial ischemia are the most frequent causes of intraoperative conversion to CPB.

The present study aimed to investigate the effects of the preoperative left ventricular ejection fraction (LVEF) on the success of OPCAB surgery as a primary outcome, and the relation of intraoperative factors to the success of OPCAB surgery and postoperative outcomes as the secondary outcomes.

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Materials and Methods

Study design and study population

The present study was a retrospective observational study conducted at a University Hospital, Bangkok, Thailand after obtaining approval from the Committee on Human Rights Related to Research Involving Human Subjects, Faculty of Medicine, University Hospital (Approval No. MURA2018/219, Protocol ID 03-61-47). The authors retrospectively reviewed from the electronic medical records of all patients underwent OPCAB surgery at Ramathibodi Hospital between January 2015 and December 2017. The study's inclusion criterion was to enlist all patients who had OPCAB surgery. However, the patients with emergency OPCAB surgery, preoperative intra-aortic balloon pump (IABP) support, and/or whose records had been lost were excluded.

Data collection and grouping

The patients were allocated to four groups based on their preoperative LVEF according to the recommendation on LVEF assessment in the 2014 Heart Failure Toolkit by the American College of Cardiology[1]: group 1 (normal), LVEF 50% to 70%; group 2 (mild dysfunction), LVEF 40% to 49%; group 3 (moderate dysfunction), LVEF 30% to 39%; group 4 (severe dysfunction), LVEF <30%. Definition of success in OPCAB surgery was the complete of myocardial revascularization without being converted to CPB coronary artery bypass graft (CABG). Conversion from OPCAB to on-pump CABG was indicated as the followings: uncontrollable intraoperative bleeding, severe hypotension even fully support with inotropes and IABP, ventricular tachycardia or ventricular fibrillation during the surgery. The authors developed data collection forms to record details of the patients' characteristics, intraoperative data, and postoperative outcomes in each group including age, sex, American Society of Anesthesiologists (ASA) physical status, weight, height, preoperative LVEF, underlying disease (diabetes mellitus, hypertension, dyslipidemia, old cerebrovascular accident, chronic kidney disease). Intraoperative data were collected as following: success of the operation, number of unplanned conversions from OPCAB surgery to on-pump CABG, amount of intravenous fluid requirement, amount of blood replacement, urine output, blood loss, inotropic and vasoconstrictor drug dosages, use of the intraoperative IABP, duration of surgery, duration of anesthesia, and number of anastomosis grafts. The postoperative data collected included the length of hospital stay, length of intensive care unit (ICU) stay, extubation time, postoperative IABP, reoperation, and death in the hospital.

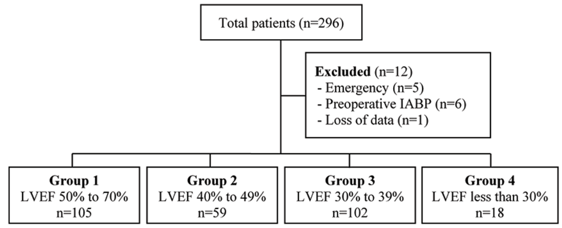

Figure 1. Flowchart of the patients evaluated and analyzed in this study.

IABP, intra-aortic balloon pump; LVEF, left ventricular ejection fraction

Statistical analysis

Data were analyzed using Stata, version 14.1 (StataCorp LP, College Station, TX, USA). The data in the study were expressed as means and standard deviations, medians and interquartile ranges, or number (percent) where appropriated. The distribution of the data was checked by the Kolmogorov-Smirnov test. Comparisons of more than 2 variables were performed by one-way analysis of variance (ANOVA) followed by LSD post-hoc multiple comparison tests. The alpha values were corrected by Bonferroni's method to avoid Type I error. Nonparametric data were analyzed by the Kruskal-Wallis analysis followed by Dunn's multiple comparison post hoc test for multiple group comparisons. Categorical data were compared using the chi-square test or Fisher's exact test as appropriated. Logistic regression was used to estimate the odds ratio (OR) and 95% confidence interval (CI) when there were significant differences in the categorical outcomes among groups. Statistical significance was set at p-value less than 0.05.

Results

Patients and baseline characteristics

Altogether, 296 patients underwent OPCAB surgery in Ramathibodi Hospital between January 2015 and December 2017 were reviewed. Among them, the authors excluded 12 patients (4.05%), 5 patients had undergone emergency surgery, 6 patients required preoperative IABP support, and one had missing data. So, there was a total of 284 patients (105 patients in group 1, 59 in group 2, 102 in group 3, and 18 in group 4) included in the present study analysis (Figure 1). Preoperative baseline patient characteristics showed no significant differences

Table 1. Preoperative characteristics (n=284)

Characteristic	Total (n=284); n (%)	LVEF values; n (%)				p-value
		Group 1 (n=105)	Group 2 (n=59)	Group 3 (n=102)	Group 4 (n=18)	
Male	213 (75.0)	77 (73.3)	45 (76.3)	79 (77.5)	12 (66.7)	0.753
Age (years); mean±SD	64.58±9.47	64.62±9.57	65.73±8.08	64.47±9.42	61.17±12.89	0.360
Body weight (kg); mean±SD	67.08±11.93	66.85±11.27	68.42±13.87	66.35±10.18	68.13±17.55	0.729
Height (cm); mean±SD	162.31±8.99	161.50±8.91	163.07±9.57	162.45±8.17	163.72±11.99	0.630
Co-morbidities						
DM	132 (46.5)	49 (46.7)	29 (49.2)	41 (40.2)	13 (72.2)	0.086
HT	227 (79.9)	85 (81.0)	49 (83.1)	76 (74.5)	17 (94.4)	0.199
DLP	157 (55.3)	63 (60.0)	30 (50.8)	53 (52.0)	11 (61.1)	0.548
Old CVA	13 (4.6)	6 (5.7)	3 (5.1)	4 (3.9)	0 (0.0)	0.849
CKD	50 (17.6)	15 (14.3)	13 (22.0)	15 (14.7)	7 (38.9)	0.050
ASA stage						0.958
II	1 (0.4)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	
III	48 (16.9)	18 (17.1)	11 (18.6)	17 (16.7)	2 (11.1)	
IV	235 (82.7)	87 (82.9)	48 (81.4)	84 (82.3)	16 (88.9)	

LVEF=left ventricular ejection fraction; DM=diabetes mellitus; HT=hypertension; DLP=dyslipidemia; old CVA=old cerebrovascular accident; CKD=chronic kidney disease; ASA=American Association of Anesthesiologists; SD=standard deviation

LVEF: group 1, 50% to 70%; group 2, 40% to 49%; group 3, 30% to 39%; group 4, <30%

ANOVA or Kruskal-Wallis test for continuous data and chi-square or Fisher's exact test for categorical data

among the 4 LVEF groups (Table 1).

Perioperative and post-operative outcomes

There was no difference in the number of patients who needed dobutamine or dopamine. However, in the patients who needed dobutamine, there was significant difference in the dobutamine dosage among groups (p=0.046). Post-hog test revealed that the dobutamine dosage was significantly higher in group 4 than in group 1 and 3 (p=0.044 and 0.038, respectively), and group 2 required a higher dobutamine dosage than group 3 (p=0.047).

The number of patients required adrenaline (p=0.008), and total number of inotropes used (p=0.031) were significantly different among the groups. Logistic regression analysis showed the relation between the adrenaline usage and the LVEF groups. Group 2, 3, and 4 received adrenaline 3.6 times (OR 3.636, 95% CI 1.478 to 8.945, p=0.005); 2.4 times (OR 2.442, 95% CI 1.048 to 5.689, p=0.039); and 5.3 times (OR 5.333, 95% CI 1.615 to 17.613, p=0.006); respectively, more than group 1. In addition, the results showed that group 4 required more intraoperative IABP for hemodynamic support during surgery than the patients in the higher LVEF groups (p<0.001, OR 6.3125, 95% CI 2.277 to 17.497) (Figure 2).

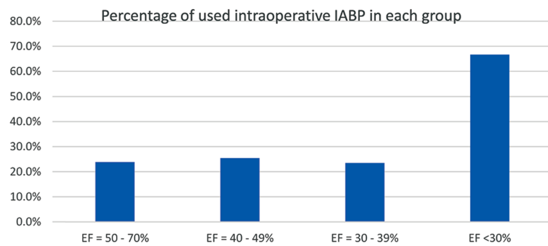

Figure 2. Percentage of intraoperative intra-aortic balloon pump (IABP) used in each group.

There were fewer anastomosis grafts in group 4 than in groups 1, 2, and 3 (p=0.027). There were no significant differences in the operative time, amount of intravenous fluid, blood transfusion requirement, or blood loss among the four groups (Table 2).

There was also no significant difference regarding the success of OPCAB surgery in each preoperative LVEF group (p=0.430). The present study showed that, in group 4, the time to extubation was significantly delayed when compared to group 3 in post hoc comparison test (mean difference 29.07 hours, 95% CI 11.75 to 46.39 hours, p=0.001), and the patients in group 4 stayed longer in the ICU when compared to group 3 in post hoc comparison test (mean difference 1.55 days, 95% CI 0.55 to 2.55 minutes, p=0.002) (Table 3).

Table 2. Operative details of the study subjects (n=284)

Variable	Total (n=284); mean±SD	LVEF group; mean±SD				p-value
		Group 1 (n=105)	Group 2 (n=59)	Group 3 (n=102)	Group 4 (n=18)	
Number of grafts	3.40±0.67	3.46±0.62	3.41±0.75	3.42±0.65	2.94±0.73	0.027*
Operation time (minute)	231.50±51.67	238.10±51.41	232.63±51.99	225.80±50.28	221.67±58.84	0.305
Blood loss (mL); median (IQR)	500 (400 to 600)	500 (400 to 600)	500 (400 to 800)	400 (300 to 600)	500 (500 to 800)	0.063
Crystalloid + colloid (mL)[a]	4,182.15±1,755.20	4,115.52±1,779.74	4,502.54±1,915.37	4,140.69±1,552.08	3,755.56±2,119.51	0.358
PRC (mL)[a]; median (IQR)	317.5 (256.0 to 529.75)	303.5 (257.0 to 544.0)	283 (247.0 to 499.0)	481 (256 to 549.5)	491.5 (294.0 to 525.5)	0.330
LPPC (mL)[a]	287.36±46.37	284.19±29.34	281.13±71.01	306.18±33.72	181	0.055
Auto blood (mL)[a]; median (IQR)	264 (186.0 to 404.0)	292 (196.25 to 457.50)	290 (200.0 to 426.0)	246 (174.0 to 373.5)	245 (174.0 to 275.0)	0.203
Urine (mL/kg/hour); median (IQR)	2.21 (1.30 to 3.49)	2.38 (1.33 to 3.43)	1.90 (1.19 to 2.92)	2.33 (1.37 to 3.83)	1.83 (0.94 to 3.08)	0.443
Dobutamine						
Number of patients; n (%)	182 (64.1)	76 (72.4)	31 (52.5)	64 (62.7)	11 (61.1)	0.082
Dose (μg/kg/minute)[a]	4.60±1.72	4.44±1.70	5.13±2.05	4.39±1.30	5.55±2.54	0.046*
Dopamine						
Number of patients; n (%)	155 (54.6)	57 (54.3)	26 (44.1)	61 (59.8)	11 (61.1)	0.254
Dose (μg/kg/minute)[a]	4.57±1.52	4.57±1.57	4.88±1.58	4.36±1.35	4.91±1.92	0.421
Adrenaline						
Number of patients; n (%)	49 (17.3)	9 (8.6)	15 (25.4)	19 (18.6)	6 (33.3)	0.008*
Dose (μg/kg/minute)[a]; median (IQR)	0.08 (0.05 to 0.125)	0.1 (0.058 to 0.125)	0.1 (0.05 to 0.160)	0.07 (0.05 to 0.10)	0.065 (0.05 to 0.085)	0.356
Norepinephrine						
Number of patients; n (%)	120 (42.3)	53 (50.5)	24 (40.7)	36 (35.3)	7 (38.9)	0.166
Dose (μg/kg/minute)[a]; median (IQR)	0.1 (0.05 to 0.15)	0.1 (0.05 to 0.15)	0.14 (0.10 to 0.16)	0.1 (0.07 to 0.15)	0.1 (0.04 to 0.17)	0.106
Number of inotropes used	1.78±0.53	1.86±0.51	1.63±0.58	1.76±0.53	1.94±0.42	0.031*
Use of the intraoperative IABP; n (%)	76 (26.8)	25 (23.8)	15 (25.4)	24 (23.5)	12 (66.7)	0.001*

LVEF=left ventricular ejection fraction; PRC=packed red blood cells; LPPC=leukocyte-poor platelet concentrate; Auto blood=autologous blood; IABP=intra-aortic balloon pump; SD=standard deviation; IQR=interquartile range

[a] Estimated from the patients who used the medication only

* p<0.05, statistical significance

Analyzed using one-way ANOVA (for all normally distributed data that is represented by mean ± standard deviation, e.g., number of grafts and operation time) and Kruskal-Wallis test (for all non-normally distributed data that is represented by median and interquartile range, e.g., blood loss and packed red blood cells)

There were statistically significant differences in postoperative arrhythmia among the groups (p=0.018). Group 2, with LVEF 40% to 49%, had a significantly higher incidence of arrhythmia than group 1 with LVEF 50% to 70% (OR 2.411, 95% CI 0.943 to 6.191), however, there was no difference in the incidence between Group 1 versus Group 3, and Group 1 versus Group 4 (Table 3).

Discussion

Coronary artery revascularization can be performed via two approaches: on-pump and off-pump techniques. Many cardiac surgeons prefer the OPCAB technique because it avoids adverse outcomes from the CPB machine and total aortic cross clamping[2].

The core of success of OPCAB surgery depends on hemodynamic stability during surgery. Hemodynamic instability during OPCAB surgery is usually caused by mechanical obstruction of cardiac inflow and outflow during manipulation of the heart and when using a heart stabilizer, which further compromises cardiac output, especially in patients with depressed left ventricular function[3-10]. If physiological intolerance to cardiac manipulation became apparent, the procedure must be changed to an on-pump technique[11,12].

The present study found the difference of preoperative LVEF was not significant to the success of the OPCAB surgery. The conversion rate in the present study was only 0.4%. Nevertheless, the previous studies reported that the overall conversion rate in OPCAB surgery to an on-pump technique was 3.7% and as high as 5.2% in patients with a LVEF of <30%[13-16]. Yoon et al reported patients with congestive heart failure and EF <35% were

Table 3. Postoperative outcomes

Variable	Total (n=284); n (%)	LVEF group; n (%)				p-value
		Group 1 (n=105)	Group 2 (n=59)	Group 3 (n=102)	Group 4 (n=18)	
Success	283 (99.6)	104 (99.0)	59 (100)	102 (100)	18 (100)	0.430
Hospital stay (hour); median (IQR)	313.0 (271.5 to 378)	310.0 (267.5 to 36.0)	309.0 (267 to 351)	315.0 (275 to 385)	383.5 (311 to 528)	0.011*
ICU stay (days); mean±SD	5.55±2.11	5.47±2.02	5.85±2.42	5.19±1.69	7.00±2.95	0.005*
Extubation time (hour); median (IQR)	23.0 (17.0 to 53.5)	23.0 (17.0 to 46.75)	22.5 (17.75 to 47.50)	23.0 (15.25 to 54.0)	60.75 (44.13 to 94.0)	0.005*
Postopperative IABP	6 (2.1)	1 (1.0)	2 (3.4)	2 (2.0)	1 (5.6)	0.254
Re-operation	3 (1.1)	2 (1.9)	0 (0.0)	1 (1.0)	0 (0.0)	0.833
Complications						
Overall	68 (23.9)	24 (22.9)	21 (35.6)	17 (16.7)	6 (33.3)	0.040*
Renal	19 (6.7)	9 (8.6)	3 (5.1)	4 (3.9)	3 (16.7)	0.156
Arrhythmia	36 (12.7)	12 (11.4)	14 (23.7)	7 (6.9)	3 (16.7)	0.018*
Stroke	3 (1.1)	0 (0.0)	0 (0.0)	3 (2.9)	0 (0.0)	0.182
Lung	3 (1.1)	2 (1.9)	0 (0.0)	1 (1.1)	0 (0.0)	0.833
Death	3 (1.1)	2 (1.9)	1 (1.7)	0 (0.0)	0 (0.0)	0.542

LVEF=left ventricular ejection fraction; ICU=intensive care unit; IABP=intra-aortic balloon pump; SD=standard deviation; IQR=interquartile range

* p<0.05, statistical significance

Analyzed using one-way ANOVA (for all normally distributed data that is represented by mean ± SD as ICU stay) and Kruskal-Wallis test (for all non-normally distributed data that is represented by median and interquartile range, e.g., hospital stay and extubation time), and Chi-square or Fisher's exact test (for categorical data that is represented by number (percentage),e.g., postop IABP and percentage of reoperation

at significant risk for on-pump conversion during OPCAB surgery[17]. Mishra et al reported the low LVEF (<25%) is a predictor of conversion during OPCAB surgery[18]. It seems that patients with severe cardiac dysfunction are unable to tolerate this procedure, however, the results of the present study indicated that preoperative LVEF did not affect the success of OPCAB surgery. Emmert et al., however, also reported that the OPCAB approach was safe in patients with low LVEF (≤25%)[19]. Similar to several previous studies[20-24]. Therefore, it was feasible and safe to do this procedure on patients with poor cardiac function. In the present study, the OPCAB surgery was conducted in the elective schedule by a highly-experienced surgeon who had performed a high volume of cases in this procedure for over 10 years, so this might be the reason that the present study had the lower conversion rate. Urso et al also demonstrated that the conversion rate was associated with the experience in the OPCAB of the surgeon[12]. A converted patient was in the group of LVEF 50% to 70%, which was the emergent conversion from the OPCAB to an on-pump beating heart due to severe unstable hemodynamics and then progressed to ventricular fibrillation, while the attempt was made from anastomoses to distal circumflex coronary. However, the surgeon successfully completed the graft anastomosis without any post-operative complications.

Fewer number of the grafts anastomoses were performed on patients with LVEF <30%, and these results are consistent with the ROOBY trial[25]. The authors did not study about the patency of grafts in each group with different preoperative LVEF, although ROOBY study reported that the patency of graft conduits were lower in OPCAB surgery than in on-pump CABG".

Low cardiac output during OPCAB surgery is managed by placing the patient in a head-down position, fluid loading, infusion of inotropes and vasopressors, and mechanical IABP support. OPCAB surgery that requires more fluid to maintain cardiac output in patients with poor cardiac functions is concerning. Nevertheless, the amount of fluid given to the LVEF <30% group was 3,755.56±2,119.51 mL, which was less than the average amount (4,182.15±1,755.20 mL), but it was no statistical significant difference. It implied, however, that fluid loading is required to maintain hemodynamics not only in the presence of good cardiac function, but also in those with poor cardiac function. Although, the present study found no significant difference between poor LVEF and good LVEF in terms of OPCAB success, the dosage of dobutamine, the adrenaline requirement, and the total number of vasopressor and inotropes used were significantly greater in patients with LVEF <30% than in those with LVEF >30%. The authors added adrenaline when the blood pressure could not be maintained by norepinephrine, dopamine, and dobutamine. The authors found that the number of patients who needed adrenaline was highest in the LVEF <30% group and accounted for 5.3 times than that of patients with normal LVEF. Therefore, the patient with LVEF lower than 30% required one or more inotropes or vasopressors to improve the cardiac contraction and to maintain the mean arterial pressure during the OPCAB surgery. However, in using of high dosage or combination of inotrope applications, it should be noted about the increasing of the myocardial oxygen demand which would result in the deterioration of the myocardial function.

IABP is used to augment myocardial performance without increasing the workload of the heart or the myocardial oxygen requirement which helps maintain stable hemodynamics during OPCAB surgery. IABP is applied to patients who do not respond to fluid, inotropes, and vasopressors treatment. It helped the patients with poor cardiac function tolerate OPCAB surgery[26-32].

The present study showed the patients with LVEF <30% need intraoperative IABP 6 to 6.5 times more than patients with LVEF >30%. The previous studies by Arom et al[33] and Gupta et al[34] also reported similar results that intraoperative IABP was used more frequently in low-LVEF groups during OPCAB surgery. Despite the benefit of IABP during OPCAB surgery, complications associated with IABP insertion were found in three cases. The first patient, with LVEF 50% to 70%, had an accidental tear of the common iliac artery. The second patient, with LVEF 40% to 49%, had acute limb ischemia and rhabdomyolysis. Both patients died in the hospital. Lastly, a patient with LVEF 30% to 39% group had thromboembolism in the right iliac artery and underwent below-knee amputation.

Regarding postoperative outcomes, the authors found that the extubation time and the length of ICU stay were longer in patients with LVEF <30% than in those with LVEF ≥30%. Gupta et al similarly reported the patients with LVEF <35% had longer extubation times and lengths of ICU stay than the patients with LVEF ≥35%[34].

Interestingly, postoperative cardiac arrhythmia occurred most often in group 2 (LVEF 40% to 49%), which deviated from the authors' expectation that it should have occurred more often in the LVEF <30% group. Permanent pacemakers were implanted in three LVEF 40% to 49% patients, and in one patient with LVEF 30% to 39%.

The authors found the present study data are valuable to ensure that the OPCAB surgery would be feasible and safe in high-risk patients with poor cardiac function.

Limitation

The present study is limited by its retrospective, non-randomized design. Various inotropic drugs were used during the surgery because the authors did not have standard protocol for inotrope usage in the authors' hospital. Drugs and dosages depended on the anesthesiologist's preference, and this may effect to the outcomes. The present study was done in a single center which may have different practice from the other institutes. For this reason, the outcomes may differ from the others. Additionally, number of patients in group 4 was much less than other groups. To assure the results of the present study, more cases of severe cardiac dysfunction are required for analysis.

Conclusion

The OPCAB surgery was safe to perform on patients with a preoperative low LVEF without any significant difference from patients with a good preoperative LVEF in terms of the success of the operation. Patients with severe preoperative cardiac dysfunction required more mechanical support with IABP, more inotropes and vasopressors to maintain the stability of the hemodynamics during surgery and prolonged the extubation time and ICU length of stay after the operation.

What is already known on this topic?

The OPCAB is an alternative technique in coronary artery revascularization. Hemodynamic instability during revascularization is the key factor to convert to an on-pump technique. Most patients with normal or mild impairment of the cardiac function were able to tolerate the hemodynamic change during cardiac manipulation, thus resulting in successful revascularization without CPB, and the conversion rate to conventional CABG with CPB was low.

What this study adds?

The OPCAB technique is feasible and safe to do on patients with very poor cardiac function (LVEF <30%), which the authors had previously been worried about the high risk to do without CPB support. This study also revealed that intraoperative uses of inotrope, vasopressor, and IABP were the crucial factors for success in OPCAB surgery in patients with poor cardiac function.

Authors' contributions

Vijitpavan A devised the study and the main conceptual ideas. Both Prachanpanich N and Vijitpavan A equally contributed to the design and implementation of the research. Prachanpanich N and Laithongkom S contributed to the data collection. Prachanpanich N and Vijitpavan A contributed to the analyses and interpretation of the results. Vijitpavan A took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analyses, and manuscript.

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Conflicts of interest

The authors declare no conflict of interest regarding the publication of the present article.

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