

Original Research Article

A comparison of clinical outcomes of LVEF $\leq 35\%$ versus LVEF $> 35\%$ in off-pump coronary artery bypass graft surgery

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ABSTRACT

Background: Management of patients with coronary artery disease (CAD) and low ejection fraction (EF) is challenging. The objective was to compare the effect of low EF to normal EF on clinical outcomes after off-pump coronary artery bypass graft (OPCABG) surgery.

Methods: All patients who underwent CABG at VMMC and Safdarjung hospital, from June 2014 till December 2016 with LVEF $\leq 35\%$ (low EF) as well as LVEF $> 35\%$ (high EF) were studied and their surgical results analyzed by collecting data retrospectively. Out of 203 total patients the LVEF was less than or equal to 35% in 41 (20.19 %) patients, more than 35% in 162 (79.81 %) patients.

Results: In LVEF $\leq 35\%$ there were 9 females and the mean age was 60.39 ± 8.76 years, The mean ICU stay in hospital was of 8.73 days, mean ventilator support was 4.01 days, inotropic support was 4.34 days, mean stay in hospital was of 28.54 days, hospital mortality was 8 (19.51%) in LVEF ≤ 35 versus mean ICU stay in hospital was of 8.73 days, ventilator support was 4.01 days, inotropic support 4.34 days, mean stay in hospital was of 20.33 days, hospital mortality was 13 (8.02%) in LVEF > 35 . These data make a survival rate of 80.49% for EF in LVEF ≤ 35 versus 91.98% for EF in LVEF > 35 .

Conclusions: CABG can be safely performed in low-EF patients with minimal postoperative morbidity and mortality in addition to encouraging home discharge rates.

Keywords: Comparison, Off pump CABG, Outcome, LVEF ≤ 35 versus LVEF > 35

INTRODUCTION

Despite improvements in medical therapies and surgical techniques, the management of patients with coronary artery disease (CAD) and low left ventricular ejection fraction (LVEF) is still challenging. Heart transplantation offers excellent results with a 65.6% 5-year survival rate; however, the scarcity of donor organs makes this option impractical for a majority of patients.¹ Coronary artery bypass grafting (CABG) has shown to be superior to medical therapy alone for low EF patients, demonstrating significant clinical improvement and long-term survival.²⁻⁶ Nevertheless, CABG in patients with reduced left

ventricular (LV) function remains a surgical challenge. For example, hospital mortality associated with LV dysfunction cases is still higher than that for normal LV function cases.⁷⁻⁹

Off-pump coronary artery bypass (OPCAB) grafting have been increasingly adopted in an effort to prevent deleterious effects of cardiopulmonary bypass, including the associated inflammatory response, global myocardial ischemia, reperfusion injury, so it helps to preserve the heart function. The low left ventricular ejection fraction (LVEF) patients have fragile heart function and may not be able to tolerate the ischemia and reperfusion in

conventional CABG. So the low LVEF patients could be the best candidate for OPCAB.^{10,11} The outcome of CABG in patients with post-ischaemic left ventricular dysfunction has improved over time. However, the low ventricular functional status still plays a major contribution to morbidity and mortality. The objective was to compare the effect of low EF to normal EF on clinical outcomes after off-pump coronary artery bypass grafting (CABG).

METHODS

All patients who underwent CABG (coronary artery bypass graft) surgery at Vardhaman Mahaveer Medical College and Safdarjung hospital, from June 2014 till December 2016 with LVEF \leq 35% (low EF) as well as LVEF $>$ 35% (high EF) were studied and their surgical results analyzed by collecting data retrospectively.

Inclusion criteria

The inclusion criteria for the patient selection were the diagnosis of coronary artery disease appropriate for CABG on preoperative angiography and LVEF \leq 35% as well as $>$ 35% detected by two-dimensional echocardiography. All patients were operated by off pump CABG. Post-operative morbidity and mortality up to discharge from hospital was studied.

Exclusion criteria

The exclusion criteria for this series were comprised of those with end-stage renal failure on dialysis, valvular heart disease (including more-than-moderate mitral regurgitation), acute myocardial infarction, previous cardiac surgery, congestive heart failure at admission and need for ventricular aneurysmectomy or other surgical procedures. Out of 203 total patients the LVEF was less than or equal to 35% in 41 (20.19 %) patients, more than 35% in 162 (79.81 %) patients.

Preoperative assessment of EF

EF was measured using preoperative transthoracic echocardiogram and intraoperative transesophageal echocardiogram.

Standardized anesthetic

The technique was used in all the patients during induction, including appropriate dose of etomidate, fentanyl, midazolam, and vecuronium, morphine followed by the maintenance of Oxygen and N₂O, isoflurane. All patients had femoral sheath (5 French) inserted at the beginning of the surgery to facilitate IABP (intra aortic balloon pump) insertion within short time in the event of uncontrolled hypotension. Under general anaesthesia all patients were monitored continuously and charted with systemic arterial line and pulmonary arterial line. Continuous cardiac output (CCO), the mixed venous

oxygen saturation [MvO₂] were actively monitored and manipulated to advantage.

Operative procedure

General

Surgical access to the heart was through median sternotomy in all patients. All incisions and closure techniques were the same in all patients. The distal anastomosis for left internal thoracic artery graft or right internal thoracic artery graft was constructed with 8-0 polypropylene continuous suture and for the saphenous vein grafts 7-0 polypropylene suture was used. All proximal anastomoses of saphenous vein grafts to aorta were constructed using 6-0 poly propylene suture after partial cross clamping the aorta.

OPCAB technique

Off pump coronary artery bypass (OPCAB) graft was performed using Octopus (Medtronic) stabilizing devices to achieve target coronary artery stabilization. Posterior and lateral target coronary arteries were accessed by deep pericardial traction sutures. A mean systemic arterial pressure was maintained around 65-70 mm of Hg throughout the procedure. Intracoronary shunt of appropriate size was used while constructing the coronary anastomosis for all the vessels.

A humidified oxygen blower/mister was used to disperse the blood from the anastomotic site while constructing the distal anastomosis. The coronary artery grafting strategies were to graft left internal thoracic artery to left anterior descending artery followed by either obtuse marginal arteries or right coronary artery or diagonal arteries by saphenous venous grafts whichever was critically stenosed, right internal thoracic artery to right coronary artery or bilateral Y to distal arteries.

Operative variables

It comprised of technique used for coronary revascularization off-pump in all, numbers of bypass grafts. Intraoperatively IABP used whenever necessary. At the end of surgery, the patients were transferred to the intensive care unit (ICU) and managed for ventilator support, hemodynamic stabilization, temperature, fluid, and electrolyte balance. The patients were extubated as soon as they met the following criteria: consciousness with pain control, acceptable respiratory force and arterial blood gas, hemodynamic stability, normothermia, and no excessive bleeding.

Postoperative outcome

Postoperative outcome variables include sepsis, reoperation for bleeding, gastrointestinal bleeding, renal failure, respiratory failure, hepatic failure, IABP insertion, ventilator support, inotropic support, ICU

stay, total hospital stay (from the day of operation to discharge), in-hospital mortality.

RESULTS

Out of 203 total patients the LVEF was less than or equal to 35% in 41 (20.19%) patients, more than 35% in 162 (79.81%) patients (Table 1).

Table 1: Number of patients in study.

LVEF	EF≤35%	EF >35
No. of patients	41 (20.19%)	162 (79.81%)

In LVEF≤35% there were 9 females and the mean age was 60.39±8.76 years, recent myocardial infarction (less than 4 weeks) is 26 (63.41%). Risk factors like diabetic mellitus, 23 (56.09%), hypertension in 29 (70.73%) smoking in 11 (26.82%), chronic obstructive pulmonary disease (COPD) in 10 (24.39%).

In LVEF>35% there were 18 (11.11%) females and the mean age was 54.26±9.51 years, recent myocardial infarction (less than 4 weeks) in 73 (45.06%). Risk factors like diabetic mellitus in 64 (39.51%), hypertension in 116 (71.60%), smoking in 24 (14.81%), COPD in 21 (12.96%) (Table 2).

Table 2: Baseline characteristics of patients undergoing CABG.

Variables	EF≤35%	EF >35	P-value
Age in years	60.39±8.76	54.26±9.51	0.0021
Female	9 (21.95%)	18 (11.11%)	0.0336
DM	23 (56.09%)	64 (39.51%)	0.027
HTN	29 (70.73%)	116 (71.60%)	0.456
COPD	10 (24.39%)	21 (12.96%)	0.034
Smoking	11 (26.82%)	24 (14.81%)	0.034
Recent myocardial infarction	26 (63.41%)	73 (45.06%)	0.017

In LVEF≤35% among diseased vessels left main artery greater than 50% was in 11 (26.83%) patients; LAD more than 70% in 36 (87.80%), RCA/PDA more than 70% in 35 (85.36%) and circumflex artery more than 70% in 34 (82.92%) (Table 3).

Table 3: Coronary vessel disease distribution.

Variables	EF≤35%	EF >35	P-value
LMD	11 (26.83%)	24 (14.81%)	0.034
LAD	36 (87.80%)	123 (75.92%)	0.049
RCA	35 (85.36%)	118 (72.83%)	0.048
Circumflex	34 (82.92%)	113 (69.75%)	0.045

Table 4: Conduits used.

Conduits used	EF≤35%	EF >35	P-value
LIMA	39 (95.12%)	158 (97.53%)	0.208
RIMA	1 (2.43%)	5 (3.08%)	0.412
BIARTERIAL	2 (4.87%)	3 (1.85%)	0.131
RSVG	40 (96.56%)	144 (88.88%)	0.044

The conduits used were: left internal mammary artery (LIMA): 39 (95.12%); right internal mammary artery (RIMA) 1 (2.43%); bilateral internal mammary arteries (BIMA) 2 (4.87%); saphenous vein graft (SVG) 40 (96.56%). In LVEF>35% among diseased vessels left main artery greater than 50% was in 24 (14.81%) patients; LAD more than 70% in 123 (75.92%);

RCA/PDA more than 70% in 118 (72.83%) and circumflex artery more than 70% in 113 (69.75%). The conduits used were: left internal mammary artery (LIMA): 158 (97.53%); right internal mammary artery (RIMA) in 5 (3.08%), bilateral internal mammary arteries (BIMA) in 3 (1.85%); saphenous vein graft (SVG) in 144 (88.88%) (Table 4).

Table 5: Postoperative complications.

Variables	EF≤35%	EF >35	P-value
IABP insertion during or after surgery	11 (26.82%)	24 (14.81%)	0.034
Bleeding requiring reoperation	5 (12.19%)	8 (4.93%)	0.044
Sepsis	6 (14.63%)	10 (6.17%)	0.035
Renal failure (required dialysis)	6 (14.63%)	10 (6.17%)	0.035
Hepatic failure	6 (14.63%)	10 (6.17%)	0.0359
Respiratory failure	6 (14.63%)	13 (8.02%)	0.040
sternal wound infection	5 (12.19%)	8 (4.93%)	0.044

The intra-aortic balloon pump (IABP) had been used in emergency situations in 11 (26.82%) patients of LVEF≤35% and 24 (14.81%) in patients LVEF>35%. 5

(12.19%) patients had been re-explored for bleeding in LVEF \leq 35 versus 8 (4.93%) patients have been re-explored for bleeding in LVEF $>$ 35. 6 (14.63%) patients required post-operative dialysis (peritoneal or haemodialysis) in LVEF \leq 35 versus 10 (6.17%) in LVEF $>$ 35. 5 (12.19%) patients developed sternal wound infection in LVEF \leq 35 versus 8 (4.93%) patients in LVEF $>$ 35. 6 (14.63%) patients developed respiratory failure in LVEF \leq 35 versus 13 (8.02%) in LVEF $>$ 35. 6 (14.63%) patients developed hepatic failure in LVEF \leq 35 versus 10 (6.17%) in LVEF $>$ 35. 6 (14.63%) patients developed sepsis in LVEF \leq 35 versus 10 (6.17%) in LVEF $>$ 35 (Table 5).

Table 6: Discharge status.

Variables	EF \leq 35%	EF $>$ 35	P-value
Ventilator support (days)	4.00	2.54	0.0460
Inotropic support (days)	4.34	3.07	0.0495
ICU stay (days)	8.73	4.26	0.0096
Hospital stay (days)	28.54	20.33	0.0022
In hospital mortality	8 (19.51%)	13 (8.02%)	0.01539

The mean ICU stay in hospital was of 8.73 days, mean ventilator support was 4.01 days, inotropic support was 4.34 days, mean stay in hospital was of 28.54 days, hospital mortality was 8 (19.51%) in LVEF \leq 35 versus mean ICU stay in hospital was of 8.73 days, ventilator support was 4.01 days, inotropic support 4.34 days, mean stay in hospital was of 20.33 days, hospital mortality was 13 (8.02%) in LVEF $>$ 35. These data make a survival rate of 80.49% for EF in LVEF \leq 35 versus 91.98% for EF in LVEF $>$ 35.

DISCUSSION

Patients with CAD and advanced ventricular dysfunction have poor prognoses with medical treatment alone despite recent advances. The coronary artery surgery study (CASS) study demonstrated that only 38% of medically treated patients (EF \leq 35%) were alive and free of moderate or severe limitations 5 years after the onset of treatment.² Surgical approaches to CAD patients with low EF include CABG, ventricular remodelling, and cardiac transplantation. Luciani et al reported an 82% 5-year actuarial post transplant survival rate in patients with ischemic heart disease and a left ventricular EF $<$ 30.¹² However, organ shortages remain a long-standing problem and only a small proportion of CAD patients with low EF can benefit from cardiac transplantation. Studies evaluating ventricular reconstruction are currently underway, and this option may become an attractive alternative treatment in the near future.¹³

CABG in low-EF CAD patients has been reported to be superior to medical therapy by several authors.^{14,15}

Alderman et al showed that patients with an EF \leq 35% who were treated with medical management had a 43% 5-year survival rate compared with a 63% 5-year survival in the surgically treated patients.² Passamani et al followed a group of CABG patients with an EF $>$ 50% for 7 years and showed that 84% of the surgically treated patients were alive at 7 years, whereas only 70% of medically treated patients were alive.⁶ Furthermore, in a study by Di Carli et al there was a significant decrease in anginal symptoms after CABG treatment compared with medically treated patients in which no significant change was observed.⁵

Although CABG provides superior benefits in survival and quality of life over medical therapy, outcomes of low-EF patients after surgery have been shown to be considerably worse than high-EF patients. This study has shown that low-EF patients had a higher incidence of preoperative co morbid conditions like higher age group, female sex, diabetic mellitus, COPD, history of smoking and recent myocardial infarction. However in this study hypertension has no significance in both groups. Islamoglu et al showed age and NYHA class to predict an increased incidence of postoperative morbidities.¹⁸

Bouchart et al also observed increased respiratory, renal, and cardiac complications in the low-EF group.¹⁶ Among diseased coronary artery distribution left main artery, LAD, RCA and circumflex are more affected in low EF group. In this study the in-hospital mortality rate was 8 (19.51%) for patients with an EF \leq 35% and 13 (8.02%) for patients with an EF $>$ 35% which is quite higher and significant in low EF patients. The mean total hospital length of stay, ICU stay, ventilator support, inotropic support was higher and significant for the low-EF group (EF \leq 35%) compared high-EF (EF $>$ 35%) group. Di Carli et al reported 9.3% 30-day perioperative mortality in patients with EF \leq 40%.⁵ Christakis et al demonstrated a 9.8% operative mortality rate in patients with EF \leq 20%, and Carr et al have shown an 11% per operative death rate in patients with EF between 10% and 20%.^{8,17}

These mortality rates decline over time, showing a clear improvement from the double-digit rates reported before 1990. Improvements in cardiac anaesthesia, surgical technique, extracorporeal perfusion, preoperative care, and postoperative management have contributed significantly to more encouraging outcomes. Case selection has been shown to be an important factor in achieving favourable outcomes after CABG in CAD patients with low EF.

Furthermore, alternative medical or intervention treatment options might be considered in low EF patients presenting with acute myocardial infarction.

There are several limitations of this study. Clinical outcomes are restricted to postoperative in-hospital morbidity and mortality only.

CONCLUSION

CABG can be safely performed in low-EF patients with minimal postoperative morbidity and mortality in addition to encouraging home discharge rates. Preoperative evaluation of myocardial viability in this group of patients using PET scanning or dobutamine echocardiography might additionally improve outcomes of this surgical approach. Low-EF patients could greatly benefit with respect to increased postoperative EF, increased long-term survival, improvement in NYHA classification, and higher quality of life. Strong predictors of worse outcomes, including renal failure on dialysis, hepatic failure, COPD, sepsis, uncontrolled diabetic mellitus, recent myocardial infarction and advanced age might be considered in patient selection for surgical approach.

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