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OUTCOMES OF CORONARY ARTERY BYPASS GRAFTING IN PATIENTS WITH REDUCED LEFT VENTRICULAR EJECTION FRACTION: A SINGLE-CENTER RETROSPECTIVE ANALYSIS

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ABSTRACT

Background: Coronary artery bypass grafting (CABG) remains the preferred revascularization strategy for patients with complex coronary artery disease, particularly those with reduced left ventricular ejection fraction (LVEF). However, patients with LVEF < 50% present unique surgical challenges and are associated with higher perioperative morbidity and mortality. This study aimed to evaluate the effectiveness and safety of CABG in patients with reduced LVEF compared to those with preserved systolic function. **Methods:** A retrospective analysis was conducted on 248 patients who underwent CABG between January 2022 and December 2025. Patients were divided into two groups: reduced ejection fraction group (LVEF < 50%, n=118) and preserved ejection fraction group (LVEF ≥ 50%, n=130). Perioperative outcomes, including mortality, intra-aortic balloon pump (IABP) implantation rates, and postoperative complications, were compared between groups. **Results:** Patients in the reduced ejection fraction group presented with significantly higher proportions of prior myocardial infarction (16.9% vs. 3.8%), ventricular aneurysm (4.2% vs. 0%), and mitral regurgitation (4.2% vs. 0%) ($P < 0.05$). In-hospital mortality was significantly higher in the reduced ejection fraction group (2.5% vs. 0.8%, $P < 0.05$), as was the rate of IABP implantation (33.1% vs. 10.8%, $P < 0.001$). No significant differences were observed between groups regarding hospital stay, number of distal anastomoses, postoperative drainage volume, or wound infection rates ($P > 0.05$). **Conclusions:** Reduced LVEF significantly increases the risk and technical complexity of CABG, with higher mortality and IABP utilization rates. However, with appropriate perioperative management, including meticulous surgical technique, optimal myocardial protection, and proactive circulatory support, acceptable outcomes can be achieved in this high-risk patient population.

INTRODUCTION

Coronary artery bypass grafting (CABG) remains the cornerstone surgical treatment for coronary artery disease (CAD), offering durable revascularization and improved long-term outcomes for patients with complex coronary anatomy.[1] Despite significant advances in percutaneous coronary intervention and medical therapy, CABG continues to be the preferred revascularization strategy for patients with multivessel disease, left main coronary artery involvement, and those with reduced left ventricular function.[2]

The epidemiology of CAD has evolved considerably in recent decades, with the disease increasingly affecting younger individuals and presenting with more advanced manifestations, including myocardial infarction, heart failure, and impaired left ventricular ejection fraction (LVEF).[3] Left ventricular dysfunction, traditionally defined as LVEF < 50%, represents a particularly challenging patient subset, as it is associated with higher perioperative morbidity and mortality following cardiac surgery.[4] Patients with reduced LVEF often present with complex clinical profiles, including prior myocardial infarction, ventricular remodeling, mitral regurgitation, and ventricular aneurysm formation, all of which contribute to increased surgical complexity and procedural risk.[5]

Revascularization procedures have been demonstrated to restore myocardial function and enhance long-term outcomes in patients with ischemic cardiomyopathy.[2] For patients with reduced LVEF, successful CABG can promote left ventricular reverse remodeling, improve myocardial perfusion, and potentially reverse the deleterious effects of chronic ischemia.[6] However, the surgical management of these patients presents unique challenges, including difficulties in myocardial protection, increased susceptibility to hemodynamic instability during cardiac manipulation, higher rates of low cardiac output syndrome, and greater reliance on mechanical circulatory support.[7, 8]

Current risk stratification tools, including the Euro SCORE and the American College of Physicians' preoperative risk assessment, have identified reduced LVEF as an independent risk factor for adverse outcomes following CABG.[9] Patients with low ejection fraction have been shown to have higher perioperative mortality and complication rates compared to those with preserved systolic function.[10] Furthermore, reduced ejection fraction is often accompanied by cardiac enlargement, which increases the difficulty of surgical exposure and myocardial protection, and may necessitate adjunctive procedures such as mitral valve intervention or ventricular aneurysm repair.[11]

Despite the growing recognition of this high-risk patient population, limited data exist regarding the outcomes of CABG specifically in patients with reduced left ventricular ejection fraction. Most available evidence is derived from large registry studies or multicenter databases that may not adequately capture the nuances of surgical decision-making and perioperative management in this challenging cohort.[12] Single-center experiences, while limited by sample size, can provide valuable insights into practical management strategies and institutional outcomes that may inform clinical practice.[13]

The optimal surgical strategy for patients with reduced LVEF remains a subject of ongoing debate. Key considerations include the choice between on-pump and off-pump techniques, the role of intra-aortic balloon pump (IABP) support, the management of concomitant mitral regurgitation, and the indications for left ventricular reconstruction.[14, 15] Additionally, the timing of surgical intervention in relation to acute myocardial infarction, the selection of target vessels for revascularization, and the perioperative use of vasoactive agents all require careful consideration in this vulnerable patient population.[16]

Recent advances in surgical techniques, myocardial protection strategies, and perioperative care have contributed to improved outcomes in high-risk CABG patients.[17] The use of intraluminal shunts during anastomosis, meticulous surgical technique, and close collaboration between the surgical and anesthetic teams have been shown to enhance hemodynamic stability and reduce complications.[18] Furthermore, the early and proactive use of mechanical circulatory support, particularly IABP, has been associated with improved outcomes in patients with reduced ejection fraction.[19]

The present study was therefore designed to assess the effectiveness and safety of CABG in patients with reduced left ventricular ejection fraction. By comparing perioperative outcomes between patients with LVEF < 50% and those with preserved systolic function (LVEF ≥ 50%), we aimed to identify specific risk factors, evaluate the role of adjunctive interventions, and propose practical management strategies to optimize outcomes in this high-risk patient population. Our institutional experience, while representing a single-center retrospective analysis, may provide valuable guidance for the surgical management of patients with ischemic cardiomyopathy and reduced left ventricular function.

MATERIALS AND METHODS

Study Subjects and Grouping

A retrospective analysis was conducted on 248 patients who underwent CABG at The Affiliated Hospital of Yangzhou University from January 2022 to December 2025. The cohort included 142 males and 106 females, with ages ranging from 51 to 80 years (64.8 ± 8.5). Patients were divided into two groups based on left ventricular ejection fraction (LVEF). The reduced ejection fraction group comprised 118 patients whose preoperative echocardiography showed LVEF < 50%, including 72 males and 46 females, aged 55–78 years (65.6 ± 8.4). The preserved ejection fraction group included 130 patients with preoperative LVEF ≥ 50%, consisting of 70 males and 60 females, aged 51–80 years (63.4 ± 8.7).

Inclusion criteria: Patients who underwent CABG between January 2022 and December 2025.

Exclusion criteria: Emergency CABG; concurrent surgery (e.g., radiofrequency ablation for atrial fibrillation, left atrial appendage ligation, etc.); preoperative hepatic or renal dysfunction.

Surgical Procedure

All patients underwent surgery via a standard median sternotomy approach. The left internal mammary artery (LIMA) and great saphenous veins were used as conduit vessels. Preoperative ultrasound was performed to assess the diameter and flow velocity of the internal mammary artery. Intraoperative exploration of the internal mammary artery condition determined whether the LIMA was used, while the remaining vessels were bypassed using saphenous vein grafts. Heparin was administered at a dose of 1–1.5 mg/kg, and the activated clotting time (ACT) was monitored until it reached 300 seconds, after which the internal mammary artery was harvested or proximal anastomosis of the saphenous vein graft was performed. Proximal anastomoses were constructed using a 6-0 Prolene double-ended suture to connect the saphenous vein graft to the ascending aorta. Distal anastomoses were performed using a 7-0 Prolene double-ended suture to anastomose the LIMA to the left anterior descending artery (LAD). Saphenous vein grafts were constructed using antegrade sequential anastomosis, and intracoronary shunts (Inshunt) were utilized during distal anastomoses.

Preoperative case discussions were conducted to evaluate the patient's condition, assess the risk of intra-aortic balloon pump (IABP) implantation, and determine the potential need for cardiopulmonary bypass. During the procedure, when performing anastomoses on the beating heart, the decision to implant an IABP or convert to cardiopulmonary bypass was made based on cardiac movement and electrocardiographic findings. Overall, 21.8% (54/248) of patients underwent the procedure with IABP support. Immediately after surgery, graft flow was assessed using a transit time flow meter (TTFM), and all grafts met the criteria of a pulsatility index (PI) ≤ 5 and mean flow (Q) $\geq$ 15 mL/min. After meticulous hemostasis, temporary pacing wires were placed, chest tubes were inserted, and the chest was closed.

Postoperative Management

After surgery, patients were transferred to the cardiac intensive care unit (CICU) for continuous monitoring of vital signs and electrocardiography. Hemodynamic support was achieved using nitrates and/or inotropic agents such as dopamine, norepinephrine, and/or vasopressin, to maintain systolic blood pressure no lower than 100 mmHg (1 mmHg = 0.133 kPa) and heart rate around 70 beats/min, ensuring adequate perfusion of the coronary graft vessels.

Given that patients with reduced left ventricular ejection fraction often present with concurrent left ventricular dilatation, higher doses of vasoactive agents were required in the early postoperative period. Adequate sedation, mechanical ventilation, and nasogastric tube placement were provided. Antiplatelet agents, beta-blockers, and enteral nutrition were administered via the nasogastric tube as part of comprehensive therapy. Once hemodynamic stability was achieved and vasoactive agent dosages were reduced, tracheal extubation was performed, and the IABP was weaned, with close attention paid to the femoral artery puncture site.

Outcome Measures

Perioperative data were collected through retrospective medical record review. Postoperative follow-up was conducted via outpatient appointments and telephone calls. Routine echocardiography was performed to measure left ventricular end-diastolic diameter (LVEDD) and LVEF to assess changes in cardiac function. After discharge, patients were followed up through telephone interviews, WeChat, and outpatient visits. All patients underwent electrocardiography and echocardiography at 1 year postoperatively.

1.3 Statistical Analysis

The statistical method adopts SPSS 20.0 statistical software analysis. The normal distribution measurement data is expressed by the average ± standard deviation (χ), and the non-normal distribution measurement data is expressed by the median and quartile spacing. Digital data is represented by frequency (pertage). The independent sample t test or non-parametric test is used for intergroup comparison, and the χ^2 test is used for the continuous variables of the counting data. P <0.05 is statistically significant for the difference.

RESULTS

Comparison of baseline characteristics between the two groups

Patients in the reduced ejection fraction group presented with more severe disease, with significantly higher proportions of prior myocardial infarction (16.9% vs. 3.8%), ventricular aneurysm (4.2% vs. 0%), and mitral regurgitation (4.2% vs. 0%) compared to the control group (all $P < 0.05$). No significant differences were observed between the two groups regarding preoperative age, sex, hypertension, hyperlipidemia, diabetes mellitus, cerebrovascular disease, previous percutaneous coronary intervention (PCI), or left main coronary artery disease ($P > 0.05$) (Table 1).

Comparison of perioperative outcomes between the two groups

During hospitalization, a total of 4 deaths (1.6%) occurred, including 3 deaths (2.5%) in the reduced ejection fraction group, all attributed to refractory low cardiac output syndrome postoperatively, and 1 death (0.8%) in the normal ejection fraction group, attributed to frequent ventricular arrhythmias. The mortality rate was significantly higher in the reduced ejection fraction group compared with the normal ejection fraction group (2.5% vs. 0.8%, $P < 0.05$). The rate of intra-aortic balloon pump (IABP) implantation was also significantly higher in the reduced ejection fraction group (33.1% vs. 10.8%, $P < 0.05$). Patients in the reduced ejection fraction group presented with more severe baseline disease, with higher proportions of prior myocardial infarction, ventricular aneurysm, and mitral regurgitation. However, no significant differences were observed between the two groups in terms of hospital length of stay, number of distal anastomoses, postoperative drainage volume, reoperation for bleeding, or sternal wound infection rate ($P > 0.05$) (Table 2).

Table 1: Comparison of preoperative baseline clinical data between patients with reduced ejection fraction group and preserved ejection fraction group.

Clinical characteristic	Reduced EF group (n=118)	Preserved EF group (n=130)	P value
Age (years, $\overline{x} \pm s$)	65.6 ± 8.4	63.4 ± 8.7	0.687
Sex (n, %)	72 (61.0)	70 (54.4)	0.178
BMI (kg/m², $\overline{x} \pm s$)	25.4 ± 2.9	26.2 ± 3.3	0.741
Hypertension (n, %)	93 (78.8)	91 (70.0)	0.108
Hyperlipidemia (n, %)	101 (85.6)	104 (80.0)	0.365
Diabetes mellitus (n, %)	59 (50.0)	58 (44.6)	0.198
Cerebral infarction (n, %)	10 (8.5)	12 (9.2)	0.864
Prior PCI (n, %)	9 (7.6)	8 (6.2)	0.376
Left main disease (n, %)	9 (7.6)	8 (6.2)	0.376
Old myocardial infarction (n, %)	20 (16.9)	5 (3.8)	0.003
Ventricular aneurysm (n, %)	5 (4.2)	0 (0.0)	<0.001
Mitral regurgitation (n, %)	5 (4.2)	0 (0.0)	<0.001

Note: BMI: body mass index; PCI: percutaneous coronary intervention; EF: ejection fraction.

Table 2: Comparison of perioperative conditions between patients with reduced ejection fraction group and preserved ejection fraction group.

Variable	Reduced EF group (n=118)	Preserved EF group (n=130)	P value
Off-pump CABG (n, %)	3 (2.5)	3 (2.3)	0.798
Number of graft anastomoses ($\overline{x} \pm s$)	4.25 ± 0.58	4.03 ± 0.38	0.851
Postoperative drainage volume (mL, $\overline{x} \pm s$)	485.2 ± 248.6	468.7 ± 264.3	0.512
ICU stay (h, $\overline{x} \pm s$)	59.1 ± 10.2	51.2 ± 7.1	0.598
Hospital stay (d, $\overline{x} \pm s$)	13.5 ± 3.9	11.7 ± 2.5	0.289
Complications (n, %)			
Death (n, %)	3 (2.5)	1 (0.8)	0.001
IABP implantation (n, %)	39 (33.1)	14 (10.8)	<0.001
New-onset atrial fibrillation (n, %)	30 (25.4)	36 (27.7)	0.158
Re-exploration for bleeding (n, %)	3 (2.5)	3 (2.3)	0.798
Chest incision infection (n, %)	4 (3.4)	4 (3.1)	0.742

Note: CABG: coronary artery bypass grafting; OPCABG: off-pump coronary artery bypass grafting; IABP: intra-aortic balloon pump; EF: ejection fraction; ICU: intensive care unit.

DISCUSSION

According to the Euro SCORE and the preoperative surgical risk assessment published by the American College of Physicians, reduced left ventricular ejection fraction (LVEF) is an independent risk factor for patients undergoing coronary artery bypass grafting (CABG). Patients with low LVEF have been shown to have higher perioperative mortality and complication rates following CABG. Furthermore, reduced ejection fraction is often accompanied by cardiac enlargement, which increases the difficulty of surgical exposure and myocardial protection.[20, 21]

In the present study, a total of 4 in-hospital deaths (1.6%) occurred, including 3 deaths (2.5%) in the reduced LVEF group, all attributed to refractory low cardiac output syndrome postoperatively, and 1 death (0.8%) in the normal LVEF group, attributed to frequent ventricular arrhythmias. The mortality rate in the reduced ejection fraction group was significantly higher than that in the normal ejection fraction group (2.5% vs. 0.8%, $P < 0.05$).

With advances in percutaneous coronary intervention and an increasing number of elderly patients with reduced ejection fraction, it is now more common to encounter patients with diffuse coronary artery disease, a history of prior myocardial infarction, and previous PCI. For coronary revascularization in patients with reduced ejection fraction, the condition of the target vessels is particularly critical. If coronary angiography reveals favorable target vessel anatomy with suitable vessels for revascularization, surgical revascularization is feasible. When necessary, myocardial perfusion imaging can be performed to identify viable myocardium, thereby ensuring improved myocardial perfusion after CABG.[22, 23] Selecting ideal target vessels for revascularization—specifically, coronary target vessels with a diameter of ≥1.5 mm and achieving maximal revascularization may help ensure adequate blood supply to ischemic regions, restore myocardial perfusion, and improve long-term prognosis.[24, 25]

In patients with low ejection fraction, poor cardiac function renders them susceptible to ventricular fibrillation or hemodynamic instability during cardiac manipulation, which places high demands on the surgeon's technical skills. For patients with poor cardiac function following acute myocardial infarction, if hemodynamically stable, it is advisable to delay CABG for 4–6 weeks to allow for recovery. If the patient is hemodynamically unstable, prior balloon angioplasty (PCI) may be considered to improve coronary perfusion, and CABG can be performed after hemodynamic stability has been achieved.

Based on our institutional experience, we recommend the following strategies: (1) Optimize preoperative volume status and carefully evaluate coronary angiography and target vessel anatomy. (2) Minimize operative time as much as possible. (3) Use intraluminal shunts during anastomosis. (4) Perform anastomosis of the left anterior descending artery (LAD) first, as it requires minimal cardiac manipulation, and restore perfusion immediately after completing each anastomosis. (5) Gradually and gently elevate the heart to expose the distal target vessels. When performing anastomosis to the lateral wall vessels, compression of the right ventricle may lead to reduced preload and make it difficult to maintain hemodynamic stability. If necessary, this can be addressed by pericardial suspension via the inferior vena cava and suspension at the midpoint of the basal pericardial bulge to elevate the heart. The heart should be elevated gently and steadily to avoid vigorous manipulation. Close communication with the anesthesiologist should be maintained throughout the procedure, utilizing positional changes and vasoactive agents to maintain blood pressure and circulatory stability, thereby facilitating smooth completion of the operation.

In patients with reduced LVEF complicated by cardiac enlargement, chronic myocardial ischemia and prior myocardial infarction lead to myocardial fibrosis and ischemia, resulting in decreased systolic and diastolic function of viable myocardium, which is the primary cause of cardiac enlargement. Mitral regurgitation and ventricular aneurysm formation further exacerbate left ventricular dilation.

The selection of surgical indications for ischemic mitral regurgitation remains controversial.[26, 27] Intraoperative transesophageal echocardiography is routinely performed. For patients with mild to moderate ischemic mitral regurgitation, mitral valve intervention is generally not required, as the degree of mitral regurgitation often significantly improves after CABG, and such patients usually undergo successful CABG without complications. However, for patients with severe mitral regurgitation or concomitant chordal rupture, mitral valve repair or replacement is recommended.

For patients with prior myocardial infarction, cardiac remodeling often results in a spherical left ventricle, which predisposes to left ventricular dilation and reduced left ventricular function. Such hearts are difficult to manipulate intraoperatively, making CABG technically challenging and requiring particular attention during the procedure. Preoperative insertion of an intra-aortic balloon pump (IABP) may be considered for circulatory support, and if necessary, cardiopulmonary bypass should be established at the outset to facilitate CABG. The IABP implantation rate in the reduced ejection fraction group was significantly higher than that in the normal ejection fraction group (33.1% vs. 10.8%, $P < 0.05$).

Based on our institutional experience, we recommend the following approach: If the patient presents with heart failure, medical therapy should be initiated first to optimize heart failure status. For patients with mitral valve disease in whom mitral regurgitation improves with medical management, CABG alone is recommended, as ischemic mitral regurgitation will gradually diminish with the restoration of myocardial perfusion and improvement in wall motion. However, in cases of chordal rupture or severe mitral regurgitation, mitral valve repair or replacement is advised. All patients in our cohort had mild to moderate mitral regurgitation. During postoperative follow-up, we observed left ventricular reverse remodeling, improved cardiac function, and reduced mitral regurgitation, with notable enhancements in exercise tolerance and quality of life.

The need for surgical intervention in patients with left ventricular aneurysm remains rarely reported. Ventricular aneurysmectomy and plication can mechanically restore left ventricular size and geometry, thereby reversing left ventricular remodeling and improving the efficiency of left ventricular myocardial function. Some literature has suggested that for small aneurysms (diameter <3 cm) without thrombus formation, CABG alone without concomitant left ventriculoplasty may achieve comparable outcomes while simplifying the surgical procedure.[28, 29] This is consistent with our findings. We recommend that for patients with poor ejection fraction who exhibit an akinetic or mildly dyskinetic left ventricular anterior wall, intraoperative inspection often reveals viable myocardium at the anterior wall and apex, indicative of non-transmural myocardial infarction. In cases where the dyskinetic segment is large (>3 cm in diameter), contains substantial thrombus, and has a thin ventricular wall, we recommend left ventriculoplasty to restore left ventricular morphology.

Patients with reduced LVEF often need to be implanted with IABP auxiliary circulation. Although IABP increases the amplitude of the heart swing during the operation, it is conducive to cyclic stability and can effectively improve the tolerance of the heart to movement.[30, 31] Implantation of IABP increases cardiac output, increases cardiac output, improves blood ejection fraction, increases coronary blood supply, promotes the redistribution of coronary blood flow to ischemic heart muscle, improves myocardial blood supply and oxygen supply by reducing cardiac post-load and improving diastolic pressure, and with the improvement of left heart function and the increase of cardiac output, the right ventricle The front and rear loads can also be reduced. The application effect in cardiac surgery, especially CABG, is obvious. At present, IABP is widely used in the perioperative period of high-risk CABG patients, but in the past, it was usually used as a rescue measure and urgently when drug treatment was difficult to maintain cyclic stability, resulting in the delay of the best treatment timing and poor use effect. Early, active and even preventive implantation of IABP can improve the auxiliary efficacy and the success rate of surgery. As a guarantee for surgery, extracorporeal circulation can be established at any time, and extracorporeal parallelism is also an effective auxiliary method.

CONCLUSION

In Summary, reduced LVEF increases the risk level and technical difficulty of CABG, and is associated with a higher rate of IABP implantation. However, this study is a single‑center investigation with a relatively small sample size, and baseline data may be subject to selection bias. Therefore, further multi‑center studies with larger sample sizes are warranted to validate our findings.

Ethical Statement

This study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Yangzhou University School of Clinical Medicine prior to the commencement of the study.

Consent for publication

Not applicable.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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Not applicable.

Author Contributions

H.A.I.: conceptualization, study design, study proposal, manuscript writing, and submission. H.A.I.: data extraction and data analysis. H.A.I., and W.W..: manuscript revision and formatting. H.A.I., and W.W.: study guidance and final review. All authors have read and agreed to the published version of the manuscript.

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