

pISSN 2092-8335 • eISSN 2733-5380
Keimyung Med J 2025;44(1):24-29
<https://doi.org/10.46308/kmj.2025.00038>

Received: March 21, 2025

Revised: May 4, 2025

Accepted: May 13, 2025

Corresponding Author:

Sungsil Yoon, MD
Department of Thoracic and Cardiovascular
Surgery, Keimyung University Dongsan
Hospital, Keimyung University School of
Medicine, 1035 Dalgubeol-daero, Dalseo-
gu, Daegu 42601, Korea
E-mail: sungsil1st@gmail.com

Outcomes of Cardiac Surgery in Patients with Heart Failure

Sungsil Yoon, Sohyeon Park, Kyungsub Song

Department of Thoracic and Cardiovascular Surgery, Keimyung University School of Medicine, Daegu, Korea

Chronic congestive heart failure with reduced ejection fraction (EF) significantly affects survival and hospitalization rates. This multicenter study analyzed the results of cardiac surgery in patients with heart failure. We used retrospective and prospective analyses and analyzed data from 199 patients with heart failure and EF < 50% who underwent various types of cardiac surgeries, including valve surgery, aortic surgery, and coronary artery bypass grafting. Outcome measures were postoperative heart function and survival rates. The in-hospital mortality rate was 1.0%, while the 2-year cardiac death rate was 8.5%. The freedom from cardiac death rates at 6, 12, and 24 months postoperatively were 97.0%, 94.5%, and 91.5%, respectively. The freedom from readmission from heart failure rates after 6, 12, and 24 months postoperatively were 97.0%, 93.5%, and 88.4%, respectively. In risk factor analysis for mortality at 24 months postoperatively, age (odds ratio [OR], 1.241; 95% confidence interval [CI], 1.083–3.155; $p = 0.03$), chronic kidney disease with renal replacement therapy (OR, 3.154; 95% CI, 1.333–7.158; $p = 0.03$), and preoperative lower EF (OR, 0.884; 95% CI, 0.429–0.919; $p = 0.04$) were significant risk factors. Analysis using linear mixed models demonstrated significant improvements in cardiac hemodynamics and New York Heart Association class postoperatively. In conclusion, cardiac surgery in patients with heart failure showed favorable outcomes with marked improvements in heart function and symptoms.

Keywords: Cardiac surgery, Cardiac diseases, Cardiac failure

Introduction

Chronic congestive heart failure with reduced ejection fraction (EF) is a progressive disease in which cardiac dysfunction is associated with increased hospitalization and shortened survival [1-3]. With the increase in life expectancy, the number of patients with heart failure has also increased, leading to an increase in the number of patients undergoing cardiac surgery. Patients with heart failure requiring heart surgery often have other comorbidities that necessitate multidisciplinary management.

Recently, the outcomes of patients with heart failure and cardiac surgeries have been improving [4]; however, there have been only a few recent studies on cardiac surgery in patients with heart failure. In this study, we analyzed recent data to examine the effects of heart failure on postoperative prognosis.

Methods

Study population

We included data from five centers from 2018 to 2022 and conducted retrospective and prospective analyses. Trained study staff abstracted data directly from the clinical charts at each site. This study was approved by the Institution-

al Review Boards (IRB) of the coordinating center and each participating site.

This study included patients with heart failure with EF < 50% who underwent cardiovascular surgery. Patients who underwent emergency surgeries for cardiogenic shock, endocarditis, acute valvular disease, or had evidence of left ventricular dyskinesia or left ventricular aneurysm on preoperative transthoracic echocardiography were excluded.

Data collection and follow-up

We collected data on patient demographics, admission diagnoses, serum laboratory data, transthoracic echocardiography results, hemodynamic variables, and treatment outcomes. Moreover, we performed follow-up serum laboratory test and transthoracic echocardiography on admission for surgery and at 6, 12, and 24 months postoperatively. The primary endpoint was cardiac death, and the secondary endpoint was all-cause death.

The types of cardiac surgery were categorized as valve surgery (aortic or mitral valve), aortic surgery, and coronary artery bypass grafting (CABG); the analysis also included combined procedures involving more than one surgical category.

Statistical analysis

Normally distributed variables are presented as means \pm standard deviation. A linear mixed model was used to evaluate the changes in cardiac hemodynamics and New York Heart Association (NYHA) class postoperatively. Logistic regression analysis was used to analyze the risk factors for the 2-year mortality. Variables with $p < 0.2$ in the univariate analysis were included in the multivariate analysis [5], and models in the multivariate analysis were selected using backward elimination. The results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical data were analyzed using the Statistical Package for the Social Sciences (version 29.0; IBM Corp.) and R (version 4.0.2; R Foundation for Statistical Computing).

Results

We analyzed 199 patients from the Keimyung University Dongsan Medical Center (Table 1), with a mean age of 65.6 ± 9.3 years. The mean preoperative EF was $34.7\% \pm 4.7\%$. Moreover, 71.4%, 63.3%, and 43.7% of patients underwent valve surgery, CABG, and aortic surgery, respectively. Among patients who underwent surgery for aortic aneurysms, concomitant procedures were performed to address coexisting

conditions such as coronary artery disease or valvular disease. Additionally, 16.1% of patients had chronic kidney disease, including 10.6% who were on renal replacement therapy.

Preoperatively, the NYHA classification was class I, II, III, and IV in 5.5%, 56.8%, 32.2%, and 5.5% of patients, respectively. The mean preoperative N-terminal fragment-pro-b-type natriuretic peptide (NT-proBNP) levels and EF were $3,824 \pm 1,741$ pg/mL and $34.7\% \pm 4.7\%$, respectively (Table 1).

Regarding the perioperative findings (Table 2), the aortic cross-clamp and cardiopulmonary bypass times were 97.5 ± 3.5 and 160.0 ± 20.4 minutes, respectively. The mean postoperative duration of stay in the intensive care unit, mechanical ventilation, and hospital stay were 3.0 ± 0.8 days, 42.0 ± 5.0 hours, and 16.5 ± 3.5 days, respectively. Two in-hospital deaths occurred (1.0%).

The freedom from cardiac death rates at 6, 12, and 24

Table 1. Baseline patient characteristics

Variables	Patients (n = 199)
Sex, male	148 (74.4)
Age, yr	65.6 ± 9.3
Body mass index, kg/m ²	24.2 ± 5.2
Indications for surgery	
Valvular heart disease	142 (71.4)
Aortic aneurysm	87 (43.7)
Coronary artery disease	126 (63.3)
Comorbidity	
Hypertension	117 (58.8)
Diabetes mellitus	80 (40.2)
On insulin injection	8 (4.0)
Stroke	19 (9.5)
Chronic obstructive lung disease	18 (9.0)
Myocardial infarction	37 (18.6)
Within 30 days	21 (10.6)
Chronic kidney disease	32 (16.1)
On renal replacement therapy	21 (10.6)
NYHA classification	
I	11 (5.5)
II	113 (56.8)
III	64 (32.2)
IV	11 (5.5)
NT-proBNP, pg/mL	$3,824 \pm 1,741$
Preoperative transthoracic echocardiography	
Ejection fraction, %	34.7 ± 4.7
Left ventricular end-diastolic diameter, mm	53.0 ± 3.5
Left atrial volume index, mL/m ²	71.7 ± 41.5

Values are presented as number (%) or mean \pm standard deviation. NYHA, New York Heart Association; NT-proBNP, N-terminal fragment-pro-b-type natriuretic peptide.

months postoperatively were 97.0%, 94.5%, and 91.5%, respectively. The freedom from readmission from heart failure rates after 6, 12, and 24 months were 97.0%, 93.5%, and 88.4%, respectively. All-cause mortality rates at 6, 12, and 24 months postoperatively were 97.0%, 94.0%, and 89.4%, respectively. In the risk factor analysis for mortality at 24 months postoperatively, age (OR, 1.241; 95% CI, 1.083–3.155;

$p = 0.03$), chronic kidney disease with renal replacement therapy (OR, 3.154; 95% CI, 1.333–7.158; $p = 0.03$), and pre-operative lower EF (OR, 0.884; 95% CI, 0.429–0.919; $p = 0.04$) were significant risk factors (Table 3). The surgery type was not a significant risk factor for mortality.

Postoperatively, most transthoracic echocardiography and NT-proBNP values significantly improved during the follow-up period, and most outcomes improved within one year (Fig. 1). The NYHA classification score significantly improved after 24 months (Fig. 2).

Table 2. Surgical outcomes

Variables	Patients (n = 199)
Types of surgery	
Mitral valve replacement	29 (14.6)
Mitral valve plasty	19 (9.5)
Aortic valve replacement	83 (41.7)
Aortic valve plasty	2 (1.0)
Tricuspid annuloplasty	23 (11.6)
Coronary artery graft bypass surgery	126 (63.3)
Aortic cross-clamp time, min	97.5 ± 3.5
Cardiopulmonary bypass time, min	160.0 ± 20.4
Mechanical ventilation time after surgery, h	42.0 ± 5.0
Intensive care unit length of stay, days	3.0 ± 0.8
Hospital length of stay, days	16.5 ± 3.5

Values are presented as number (%) or mean ± standard deviation.

Discussion

Although the number of patients with heart failure undergoing cardiac surgery is increasing, recent studies on this topic are scarce. Our main findings showed that heart function and symptoms significantly improved postoperatively with favorable outcomes.

The in-hospital mortality rate, 2-year cardiac death rate, and readmission rate due to heart failure were 1.0%, 8.5%, and 11.6%, respectively, which were more favorable than the 8.6% in-hospital mortality rate in the study by Metkus et al. [6]. The Metkus study included patients with critical illness,

Table 3. Risk factor analysis for mortality at 24 months postoperatively (logistic regression analysis)

Parameter	Univariate analysis		Multivariate analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Sex	0.830 (0.227–9.529)	0.77	–	–
Age	1.438 (1.243–4.517)	0.03	1.241 (1.083–3.155)	0.03*
Body mass index	0.931 (0.777–1.114)	0.44	–	–
Valvular disease	1.272 (0.357–4.533)	0.71	–	–
Aortic aneurysm	2.716 (0.766–9.637)	0.12	3.815 (0.846–10.551)	0.62
CAD	1.100 (0.310–3.903)	0.88	–	–
Diabetes mellites	1.294 (0.380–4.407)	0.68	–	–
Stroke	1.040 (0.124–8.689)	0.97	–	–
COPD	0.906 (0.109–7.515)	0.93	–	–
MI	1.044 (0.215–5.081)	0.96	–	–
CKD	0.558 (0.068–4.543)	0.59	–	–
CKD with RRT	2.419 (1.483–5.437)	0.04	3.154 (1.333–7.158)	0.03*
NYHA class	1.288 (0.517–3.209)	0.59	–	–
NT-proBNP	2.154 (0.482–9.135)	0.41	–	–
Ejection fraction	0.764 (0.431–0.948)	0.02	0.884 (0.429–0.919)	0.04*
LVEDD	1.882 (0.321–3.501)	0.22	–	–
LAVI	1.008 (0.999–1.017)	0.09	1.849 (0.438–9.185)	0.73

OR, odds ratio; CI, confidence interval; –, not available; CAD, coronary artery disease; COPD, chronic obstructive lung disease; MI, myocardial infarction; CKD, chronic kidney disease; RRT, renal replacement therapy; NYHA, New York Heart Association; NT-proBNP, N-terminal fragment-pro-b-type natriuretic peptide; LVEDD, left ventricular end-diastolic diameter; LAVI, left atrial volume index.

*Significant p -value.

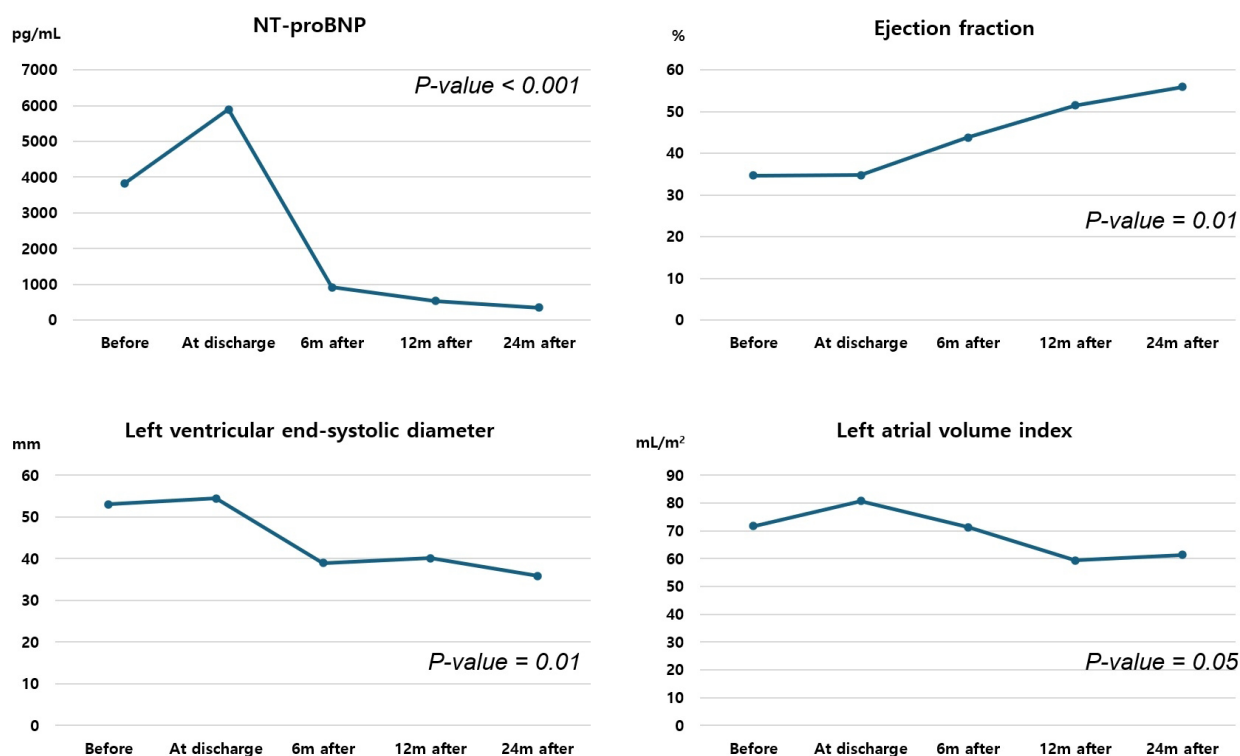


Fig. 1. Change of results of transthoracic echocardiography and NT-proBNP after cardiac surgery. NT-proBNP, N-terminal fragment-pro-b-type natriuretic peptide.

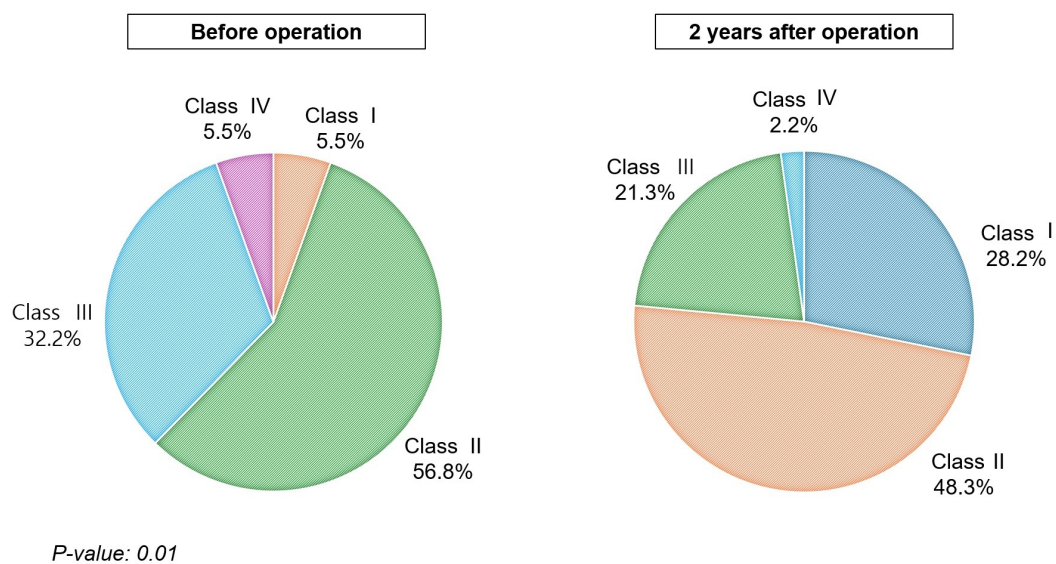


Fig. 2. Results of New York Heart Association classification at 24 months postoperatively.

including severe heart failure; therefore, a direct comparison with the present study may not be valid. Our study focused on patients with a lower EF, which may provide more specific clinical insights for surgical planning in patients with heart

failure. Furthermore, our study demonstrated improvements in symptoms and heart failure progression after cardiac surgery, which may further support surgical decision-making in patients with reduced EF [7-9].

As previously described, a postoperative recovery of heart function and improvement in the symptoms of heart failure were observed. These results are supported by previous studies, including the Surgical Treatment for Ischemic Heart Failure (STICH) trial [9], which demonstrated that coronary artery revascularization in patients with ischemic heart disease and reduced heart function improves both cardiac function and survival rates. Although we did not perform a stratified analysis according to the type of surgery, our study demonstrated postoperative improvement in cardiac function following CABG and valvular heart surgery, which is consistent with the findings of previous studies [6,10].

Despite the robustness of our findings, this study had several limitations. It had an observational design and inherent biases associated with retrospective data collection at multiple centers. In particular, causes of death other than cardiac death were not clearly identified, raising the possibility that deaths related to underlying aortic diseases may have been included in the outcome analysis, potentially introducing bias. In addition, the follow-up period was relatively short. Future studies should include a randomized controlled trial design and an extended follow-up period to fully capture the long-term benefits and risks of cardiac surgery for patients with heart failure. Second, we analyzed surgical outcomes by grouping patients who underwent different types of cardiac surgery. Therefore, we were unable to analyze the surgical outcomes according to specific types of cardiac surgery. Future studies should aim to perform stratified analyses by surgery type as additional cases become available.

In conclusion, cardiac surgery yielded acceptable results in patients with heart failure. Moreover, patients with heart dysfunction and heart failure symptoms exhibit good outcomes after cardiac surgery. Therefore, cardiac surgery should be more actively considered in cases where it is indicated for patients with heart failure.

Acknowledgements

This study was supported by a research grant (PHO0190521) from Medtronic.

Ethics approval

The study protocol was approved by the Ethics Committee of the Keimyung University Dongsan Medical Center (IRB No. 2017-09-041-033). This study was conducted according to the principles of the Declaration of Helsinki (2013). Writ-

ten informed consent was obtained from all participants.

Conflict of interest

The authors received a research grant from Medtronic (PHO0190521), but have no other conflicts of interest to disclose.

ORCID

Sungsil Yoon, <https://orcid.org/0000-0002-4374-6879>

Sohyeon Park, <https://orcid.org/0009-0009-9830-7193>

Kyungsub Song, <https://orcid.org/0000-0002-6556-2261>

References

1. Jessup M, Brozena S. Heart failure. *N Engl J Med*. 2003;348:2007–18.
2. Oostergera M, Voors AA, Pinto YM, Buikema H, Grandjean JG, Kingma JH, et al. Effects of quinapril on clinical outcome after coronary artery bypass grafting (The QUO VADIS Study). QUinapril on vascular ace and determinants of ischemia. *Am J Cardiol*. 2001;87:542–6.
3. Carson P, Wertheimer J, Miller A, O'Connor CM, Pina IL, Selzman C, et al. The STICH trial (Surgical Treatment for Ischemic Heart Failure): mode-of-death results. *JACC Heart Fail*. 2013;1:400–8.
4. Akbar AF, Zhou AL, Wang A, Feng ASN, Rizaldi AA, Ruck JM, et al. Special considerations for advanced heart failure surgeries: durable left ventricular devices and heart transplantation. *J Cardiovasc Dev Dis*. 2024;11:119.
5. Greenland S, Mickey RM. Re: “the impact of confounder selection criteria on effect estimation. *Am J Epidemiol*. 1989;130:1066.
6. Metkus TS, Alviar CL, Baird-Zars VM, Barsness GW, Berg DD, Bohula EA, et al. Presentation and outcomes of patients with preoperative critical illness undergoing cardiac surgery. *JACC Adv*. 2023;2:100260.
7. Stewart GC, Givertz MM. Mechanical circulatory support for advanced heart failure: patients and technology in evolution. *Circulation*. 2012;125:1304–15.
8. Petrie MC, Jhund PS, She L, Adlbrecht C, Doenst T, Panza JA, et al. Ten-year outcomes after coronary artery bypass grafting according to age in patients with heart failure and left ventricular systolic dysfunction: an analysis of the extended follow-up of the STICH trial (Surgical Treatment for Ischemic Heart Failure). *Circulation*. 2016;134:1314–24.

9. Velazquez EJ, Lee KL, Jones RH, Al-Khalidi HR, Hill JA, Panza JA, et al. Coronary-artery bypass surgery in patients with ischemic cardiomyopathy. *N Engl J Med*. 2016;374:1511–20.
10. Michler RE, Rouleau JL, Al-Khalidi HR, Bonow RO, Pellikka PA, Pohost GM, et al. Insights from the STICH trial: change in left ventricular size after coronary artery bypass grafting with and without surgical ventricular reconstruction. *J Thorac Cardiovasc Surg*. 2013;146:1139–45.e6.