The Egyptian Cardiothoracic Surgeon

DOI: 10.35810/ects.v6i6.311

Vol. 6, No. 6, 120 - 126

Original Article

Early Results of Coronary Artery Bypass Grafting Surgery with or without Coronary Endarterectomy

Ahmed Emara[1], Moataz Rizk[1], Ahmed Amr[2], Ibrahim Kasb[1], Yousry Shaheen[1]

[1] Department of Cardiothoracic Surgery, Faculty of Medicine, Banha University, Banha, Egypt

[2] Department of Cardiothoracic Surgery, Faculty of Medicine, Al Azhar University, Cairo, Egypt

Abstract

Background: Managing patients with diffuse coronary artery disease is challenging. The advantages of coronary endarterectomy (CE) combined with coronary artery bypass grafting (CABG) compared to CABG alone are controversial. This study compared short-term outcomes, including ICU and hospital stays, arrhythmias, postoperative myocardial infarction, renal impairment, and hospital mortality, between patients who underwent CABG without and with CE.

Methods: This randomized controlled study included 100 patients who underwent CABG with or without CE. Participants were randomly allocated into two equal groups. Group I (n=50) included patients who underwent CABG alone, and Group II (n=50) included patients who underwent CABG combined with CE.

Results: The right coronary artery was the most common vessel affected by CE (44%), followed by the left anterior descending artery (42%). Low-output syndrome and pleural effusion were more frequently observed in Group II; however, these differences did not reach statistical significance. There was no difference in postoperative complications or ejection fraction between the groups. The ICU stay was significantly longer in Group II (3.02±0.84 vs. 2.58±0.5 days; p=0.007). Additionally, patients in Group II had significantly longer hospital stays (14.48±1.87 vs. 11.98±1.35, p<0.001).

Conclusion: Compared with CABG alone, CABG with CE might not be associated with increased short-term mortality or morbidity. CABG with CE was associated with prolonged hospitalization, necessitating a careful assessment of the benefits versus an extended hospital stay when considering this adjunctive procedure.

KEYWORDS

Coronary artery bypass grafting; Coronary endarterectomy; Ischemic heart disease

Article History

Submitted: 29 Apr 2024

Revised: 22 May 2024

Accepted: 13 July 2024

Published: 1 Nov 2024

Introduction

Coronary endarterectomy is a surgical procedure that involves the meticulous extraction of atheromatous plaques from coronary arteries. This helps to re-establish the normal diameter of the vessels, thereby enhancing blood flow to the heart muscle [1, 2]. Patients with extensively compromised coronary vasculature often undergo coronary artery bypass grafting (CABG). However, CABG alone may not always provide complete revascularization. Consequently, the addition of coronary endarterectomy (CE) has become essential for ensuring adequate myocardial revascularization [1]. Furthermore, numerous

Corresponding author: Ahmed Amr eljokersurgon5@hotmail.com

studies have reported favorable perioperative outcomes in patients who undergo CABG in conjunction with CE [3].

Some studies have reported superior outcomes when CE is performed on the left anterior descending artery (LAD) compared to multivessel CE [4]. Data about CEs in the literature are controversial. While some studies have documented increased mortality rates and incidences of postoperative complications in patients undergoing CE, other research indicates favorable perioperative and postoperative outcomes associated with this procedure [5]. Because of recent advancements in surgical techniques, CE has attracted increasing amounts of attention and has been increasingly used to achieve better short- and long-term outcomes than CABG alone [2, 6]. However, CE is technically challenging, and the risk of early postoperative complications should be weighed against the long-term benefits. Therefore, this study compared short-term outcomes, including ICU and hospital stays, arrhythmias, postoperative myocardial infarction, renal impairment, and hospital mortality, between patients who underwent CABG without and with CE.

Patients and Methods

Design

This randomized study included 100 patients who underwent CABG with or without CE from May 2021 to March 2023 at a single tertiary referral center. Study approval was acquired from the Research Ethics Committees. Informed written consent was obtained from all patients prior to enrollment.

Patients

The study included adult patients (aged >18 years) of both sexes who underwent isolated, primary, or elective CABG. The exclusion criteria were patients with previous cardiac surgery, off-pump CABG, or end-organ failure.

Participants were randomly allocated on a 1:1 basis into two groups using a computer-generated randomization sequence. Group I (n= 50) included patients who underwent CABG alone, and Group II (n= 50) included patients who underwent CABG combined with CE.

Table 1: Comparison of the preoperative data between patients who underwent coronary artery bypass grafting (CABG) with (Group II) or without CE (Group I). The data are presented as the means ± SDs or frequencies (%).

	Group I (n=50)	Group II (n=50)	p-value
Age (years)	55.71± 7.05	55.41± 6.77	0.855
Male sex	45 (90%)	42 (84%)	0.554
Comorbidities			
Hypertension	23 (46%)	20 (40%)	0.686
Diabetes mellitus	18 (36%)	18 (36%)	>0.99
Smoking	22 (44%)	24 (48%)	0.841
Family history of IHD	17 (34%)	22 (44%)	0.412
Obesity	7 (14%)	3 (6%)	0.318
Hyperlipidemia	7 (14%)	6 (12%)	>0.99
Presentation			
Stable angina	23(46%)	25(50%)	0.841
Unstable angina	12(24%)	15(30%)	0.653
ST-elevation MI	13(26%)	6(12%)	0.125
Non-ST-elevation MI	2(4%)	4(8%)	0.678
Angiography			
Left anterior descending	50(100%)	50(100%)	>0.99
Right coronary	48(96%)	41(82%)	0.051
Left circumflex	40(80%)	42(84%)	0.795
Ramus intermediate	8(16%)	8(16%)	>0.99

IHD: ischemic heart disease, MI: myocardial infarction

Table 2: Comparison of the operative data between patients who underwent coronary artery bypass grafting (CABG) with (Group II) or without CE (Group I). The data are presented as the means ± SDs or frequencies (%).

	Group I (n=50)	Group II (n=50)	p-value
On-pump	50(100%)	50(100%)	>0.99
LITA graft to LAD	47(94%)	48(96%)	>0.99
Vein graft to LAD	3(6%)	2(4%)	>0.99
Type of CE	Closed 50 (100%)	-	-
Vein grafts			
Right coronary artery	30(60%)	25(50%)	0.422
Left circumflex	5(10%)	7(14%)	0.760
1st obtuse marginal	24(48%)	29(58%)	0.423
2nd obtuse marginal	10(20%)	5(10%)	0.262
Posterior descending	11(22%)	4(8%)	0.091
Ramus intermediate	7(14%)	6(12%)	>0.99
Posterior left ventricular	3(6%)	0(0%)	0.242
1st diagonal	18(36%)	10(20%)	0.118
2nd diagonal	1(2%)	3(6%)	0.617
Grafts per patient	3.02±0.44	3.2±0.44	0.036

CE: coronary endarterectomy, LITA: left internal thoracic artery, LAD: left anterior descending artery

Data

All patients underwent a detailed medical history, comprehensive clinical examination, laboratory investigations, and radiological evaluation, as well as baseline electrocardiography, echocardiography, and coronary angiography.

The data collected for the study included age, sex, hypertension status, diabetes mellitus status, smoking status, obesity status, and hyperlipidemia status. Furthermore, the patient's presentation and angiographic characteristics were reported. Operative data included the site of the distal anastomosis, type of conduit, and type of CE.

The study outcomes were hospital mortality, myocardial infarction (MI), atrial fibrillation (AF), low cardiac output (LCO), re-exploration for bleeding, pleural effusion, cerebrovascular accident, wound infection, and intensive care unit (ICU) and hospital stays.

Operative technique

Following general anesthesia induction, the patient was appropriately positioned, prepped, and draped. A midline sternotomy was performed. The pedicled left internal thoracic artery (LITA) was harvested using low-energy electrocautery, and the saphenous vein graft (SVG) was similarly harvested. Myocardial preservation was performed using aortic cross-clamping and cardioplegia infusion under mild hypothermia. After arteriotomy, the vessel was meticulously inspected for the presence of atheromatous plaques. The incision length was adjusted based on the extent and distribution of the atheromatous plaques and skip lesions observed. Intraoperative measurement of the coronary artery diameter was performed using intracoronary shunts. The suture technique was designed to exteriorize lateral plaques, creating a smooth endothelial surface at the anastomosis to minimize the likelihood of flow disturbance or thrombotic events. Proximal anastomosis of the SVG was performed on the ascending aorta following the application of a side-biting clamp. Deairing of the graft was meticulously carried out after each proximal anastomosis. The standard decannulation protocol was followed upon cessation of cardiopulmonary bypass, and protamine administration was initiated after a thorough evaluation for bleeding at the anastomotic sites, followed by chest closure.

In patients who had CE, the procedure was performed by meticulously dissecting the atheromatous plaques using a spatula, with arteriotomy extension both proximally and distally spanning several centimeters. A more extensive

anastomosis utilizing a venous patch was conducted for the reconstruction of the vessel wall. Subsequent to the endarterectomy, CABG involved direct anastomosis of the LITA or the vein graft onto the endarterectomized vessel.

Postoperative course

Postoperative data, such as inotropic support, duration of mechanical ventilation, and intra-aortic balloon pump (IABP) requirements, were reported. The postoperative duration of hospitalization, indices of morbidity, and outcomes regarding mortality were also documented. For patients without CE, intravenous heparin, low-dose aspirin (150 mg/day), and clopidogrel (75 mg/day) were administered promptly in the postoperative phase. In patients subjected to CE, warfarin initiation followed intravenous heparin bridging until the target INR of 2.0 to 2.5 was achieved in conjunction with aspirin. Warfarin therapy was prescribed for three months post-surgery. Postoperative follow-up assessments were conducted at 1 and 6 months, including standard 12-lead ECG and 2D echocardiography at the three-month follow-up. Coronary angiography was performed if new symptoms emerged, ECG deviations were observed, or regional wall motion abnormalities were identified in subsequent echocardiographic assessments.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). The assessment of data distribution normality was conducted via the Shapiro–Wilk test. The descriptive statistics included the numerical data's means and standard deviations (± SDs), while the nonnumerical data were presented as frequencies and percentages. The analyses included various tests: Student's t-test for comparing means between two study groups, the Mann–Whitney test U test for nonparametric variable differences between groups, the chi-squared test for exploring relationships between qualitative variables, and the Wilcoxon test for evaluating nonparametric variable differences at different time points. A p-value of <0.05 at the 95% confidence interval was considered to indicate statistical significance for interpreting the results.

Results

Preoperative data

The mean age, sex, and overall comorbidities were not significantly different between the studied groups. Patient presentation and angiographic characteristics did not differ significantly between the groups (Table 1).

Operative data

All patients underwent on-pump surgery. CE was performed using a closed technique in all patients. There was no difference in the distribution of venous grafts between the two groups. The average number of grafts per patient was significantly lower in Group I than in Group II (p=0.036) (Table 2). The results for the endarterectomized arteries are presented in Table 3.

Table 3: Number of endarterectomized vessels in patients who underwent coronary endarterectomy. The data are presented as numbers (%).

	(n=50)
Right coronary artery	22 (44%)
Left anterior descending	21 (42%)
Left circumflex	7 (14%)
Ramus intermediate	2 (4%)
1st diagonal	2 (4%)
2nd diagonal	1 (2%)
2nd obtuse marginal	1 (2%)

Postoperative outcomes

There were no significant differences in postoperative complications between the two groups. The average duration of ICU stay was longer in Group II than in Group I (p=0.007). Additionally, Group II also had a longer duration in contrast to Group I (p<0.001) (Table 4).

Follow-up

The difference in the ejection fraction was not statistically significant between the two groups (p=0.641). After three months, both groups showed an improvement in EF; however, the difference between the groups was not statistically significant (p=0.751). The comparison between pre- and postoperative ejection fractions

Table 4: Comparison of postoperative data between patients who underwent coronary artery bypass grafting (CABG) with (Group II) or without CE (Group I). The data are presented as the mean ±SD or frequency (%)

	Group I (n=50)	Group II (n=50)	p-value
Hospital death	1(2%)	1(2%)	>0.99
Myocardial infarction	2(4%)	1(2%)	>0.99
Atrial fibrillation	3(6%)	4(8%)	>0.99
Ventricular arrhythmia	1(2%)	0(0%)	>0.99
Low-output syndrome	2(4%)	0(0%)	0.495
Reopen (Bleeding)	2(4%)	2(4%)	>0.99
Pleural effusion	5(10%)	1(2%)	0.204
Cerebrovascular accident	1(2%)	0(0%)	>0.99
Wound infection	2(4%)	3(6%)	>0.99
Intensive care unit stay (days)	2.58±0.5	3.02±0.84	0.007
Hospital stay (days)	11.98±1.35	14.48±1.87	<0.001

revealed significant improvement (p<0.001 for both groups) (Table 5).

Discussion

Coronary endarterectomy remains a controversial issue in cardiac surgery. This randomized study compared the short-term outcomes between patients who underwent CABG alone and those who underwent CABG or CE for diffusely diseased coronary arteries. The number of bypass grafts was significantly greater in patients with CE. The right coronary artery was the most common vessel affected by CE, followed by the left anterior descending artery. There was no difference in postoperative complications or ejection fraction between the groups. Patients who underwent CE had longer ICU and hospital stays.

In the investigation conducted by Sirivella and associates, CE was carried out on 2,201 vessels, encompassing 714 LADs, 140 diagonal branches, 60 distal branches of the main circumflex, 244 obtuse marginal branches, 758 right coronary arteries (RCA), 203 posterior descending coronary arteries, and 82 posterolateral branches [7]. In the study conducted by Ellouze and coworkers, triple bypass procedures were performed on 91 patients (62%), while quadruple bypass surgeries were performed on 33 patients (22%). CE procedures targeted the RCA in 108 individuals (70% of the cohort), a subsidiary branch of the circumflex artery in 22 patients (14%), the LAD artery in 21 patients (14%), and the diagonal branches in 3 patients (2%), demonstrating the complex focus on different coronary arterial territories within the study population. Prior to the initiation of bypass grafting with an ITA graft, the arteriotomy was secured using saphenous vein patches in 13 patients (9%). The inclusion of endarterectomy procedures contributed to achieving complete revascularization in 128 patients (87%) [8]. This finding is consistent with our study, in which patients with CE had significantly greater bypass grafts.

Table 5: Comparison of the postoperative and follow-up ejection fractions and medications between patients who underwent coronary artery bypass grafting (CABG) with (Group II) or without CE (Group I). The data are presented as the mean ±SD or frequency (%)

	Group I (n=50)	Group II (n=50)	p-value
Preoperation ejection fraction	53.79± 6.13	53.27± 4.67	0.641
EF after 6 months	59.17± 6.74	58.6± 5.13	0.751
Same group comparison	p_1= <0.001	p_2= <0.001	
Aspirin + clopidogrel	46 (92%)	0	<0.001
Aspirin + warfarin	4 (8%)	50 (100%)	<0.001

EF: ejection fraction

The ramus intermedius, first diagonal, and second diagonal arteries were infrequently endarterectomized, with each being treated in only 2 (4%), 2 (4%), and 1 (2%) of the patients, respectively. The second obtuse marginal artery was also rarely endarterectomized, with only one patient (2%) undergoing this procedure.

The incidence of postoperative complications was similar between the two groups, indicating comparable safety profiles for both surgical approaches. Although low-output syndrome and pleural effusion were more frequently observed in the group that underwent CABG with CE, these differences did not reach statistical significance. Ellouze and associates reported no mortality during hospitalization following CABG surgery. Perioperative MI was reported in seven patients (5%), and an intra-aortic balloon pump was required in five patients [8]. The average ICU stay duration demonstrated a pronounced increase in patients with CE, with an average of 3.02±0.84 days, compared to CABG alone, which had an average of 2.58±0.50 days. Similarly, hospital stay was longer in CE patients, averaging 14.48±1.87 days, in contrast to CABG alone, where the average hospital stay was 11.98±1.35 days. Sirivella and coworkers observed that within the CE cohort, there was an increase in the duration of stay in the ICU (2.8 ± 4 vs. 1.2 ± 1 days; $p < 0.001$) and the overall hospitalization period (7.9 ± 7 vs. 6.2 ± 3 days; $p = 0.005$). This trend correlated with an increased requirement for blood component therapy (7.2 ± 8 vs. 2.9 ± 6 units; $p < 0.0001$) [7].

Patients with CE require a special anticoagulation regimen. None of these patients had a combination of aspirin and clopidogrel, while a vast majority of CABG patients (92%) were on this medication regimen. Conversely, all patients with CE received a combination of aspirin and warfarin, compared to only 4 (8%) CABG patients who received warfarin because of atrial fibrillation. Ranjan and colleagues reported that subsequent to CE, standard heparin infusion was administered to forestall thrombotic events in grafts or native tissue during the initial postoperative phase, transitioning to oral warfarin therapy for the subsequent 3 to 6 months [9], a practice commonly adopted by other clinicians as well [10, 11].

CE combined with CABG is still challenging, and our study showed comparable short-term outcomes. Future studies comparing long-term outcomes and comparing CE techniques are needed [12].

Limitations of the study

The study had a relatively small sample size and was a single-center study, which might limit the generalizability of the findings. The study solely concentrates on immediate outcomes, thereby limiting the comprehensive understanding of how well the interventions maintain their effectiveness and durability over an extended period.

Conclusion

In the short-term assessment, the addition of coronary endarterectomy to CABG did not significantly alter mortality or morbidity compared with CABG alone. Both approaches effectively improved cardiac function. However, CABG with CE was associated with prolonged hospitalization, necessitating a careful assessment of benefits versus an extended hospital stay when considering the adjunctive procedure.

Funding: Self-funded
Conflict of interest: Authors declare no conflict of interest.

References

1. Ruiz-Carmona C, Diaz-Duran C, Sevilla N, Cuadrado E, Clará A. Long-term Survival after Carotid Endarterectomy in a Population with a Low Coronary Heart Disease Fatality: Implications for Decision Making. Ann Vasc Surg. 2016; 36: 153-8.
2. Gummert JF, Funkat A, Beckmann A, et al. Cardiac surgery in Germany during 2006: a report on behalf of the German Society for Thoracic and Cardiovascular Surgery. Thorac Cardiovasc Surg. 2007;55(6):343-50.
3. Janiec M, Ragnarsson S, Nozohoor S. Long-term outcome after coronary endarterectomy adjunct to coronary artery bypass grafting.

Interact Cardiovasc Thorac Surg. 2019;29(1):22-7.
4. Robu M, Marian DR, Lazăr E, et al. Open Coronary Endarterectomy of Left Anterior Descending Artery-Case Report and Review of Literature. J Cardiovasc Dev Dis. 2022;9(3).
5. Byrne JG, Karavas AN, Gudbjartson T, et al. Left anterior descending coronary endarterectomy: early and late results in 196 consecutive patients. Ann Thorac Surg. 2004;78(3):867-73.
6. Kato Y, Shibata T, Takanashi S, Fukui T, Ito A, Shimizu Y. Results of long segmental reconstruction of left anterior descending artery using left internal thoracic artery. Ann Thorac Surg. 2012;93(4):1195-200.
7. Sirivella S, Gielchinsky I, Parsonnet V. Results of coronary artery endarterectomy and coronary artery bypass grafting for diffuse coronary artery disease. Ann Thorac Surg. 2005;80(5):1738-44.
8. Ellouze M, Bouchard D, Pham M, et al. Coronary endarterectomy in patients with diffuse coronary artery disease: assessment of graft patency with computed tomography angiography. Can J Surg. 2022;65(5):E635-e41.
9. Ranjan R, Adhikary D, Mandal S, Seedher A, Adhikary AB. Outcome of coronary endarterectomy with coronary artery bypass grafting in patients with diffuse coronary artery disease in Bangladesh: A retrospective cohort study. JRSM Cardiovasc Dis. 2017;6:2048004017732658.
10. Ranjan R, Adhikary D, Saha H, Saha SK, Hasan K, Adhikary AB. Coronary atheroma [14 cm] extracted from the right coronary artery during off-pump coronary artery bypass grafting. Bangabandhu Sheikh Mujib Medical University Journal. 2017;10:97-100.
11. Chen A, Stecker, E, A Warden B. Direct Oral Anticoagulant Use: A Practical Guide to Common Clinical Challenges. J Am Heart Assoc. 2020;9(13):e017559.
12. Fayad ESA, Amr MA. Short-term outcomes of reconstruction of extensively diseased left anterior descending artery with or without endarterectomy: a propensity score analysis. Cardiothorac Surg 29, 6 (2021).