Koşuyolu Heart Journal

Koşuyolu Heart J 2026;29(1):26–33
DOI: 10.51645/khj.2026.562

Original Article

Early Post-Operative Results of Patients Undergoing Coronary Endarterectomy in Addition to Coronary Artery Bypass Grafting Surgery

Alizamin Yusifli,[1] Mehmet Erdem Toker[2]

[1]Department of Cardiovascular Surgery, Medicana International Hospital, İzmir, Türkiye
[2]Department of Cardiovascular Surgery, Koşuyolu High Specialization Training and Research Hospital, İstanbul, Türkiye

Abstract

Objective: Coronary artery bypass grafting (CABG) operation maintains its importance as one of the most important treatment methods in the treatment of coronary artery disease (CAD). One of the main goals of this surgery is to achieve complete revascularization. CABG operation may be insufficient to provide complete revascularization in patients with diffuse CAD. In this case, coronary endarterectomy (CE) may be a treatment option. Our aim in our study is to investigate the post-operative early mortality and morbidity outcomes of patients who underwent CE in addition to CABG and the effect of CE on these results.

Methods: Our study included 183 patients who underwent CE in addition to CABG surgery between January 01, 2017 and December 31, 2021. Patients with isolated CABG were included in our study and patients who underwent an additional procedure and redo surgeries were excluded from the study. The data of the patients were analyzed retrospectively, hospital database, archive records, and patient files were examined. Pre-operative, intraoperative, and post-operative data of the patients were examined.

Results: The study was conducted with a total of 183 subjects, 139 (76%) male and 44 (24%) female, whose ages ranged from 30 to 85. Early post-operative myocardial infarction was observed in 13.1% of the cases, and early mortality was observed in 8.7%.

Conclusion: CE is an effective method to provide complete revascularization in patients with diffuse CAD, and it is a technique that should be applied in cases where there is no suitable area for anastomosis in the extensively diseased coronary artery.

Keywords: Coronary artery bypass grafting; coronary artery disease; coronary endarterectomy.

Cite This Article: : Yusifli A, Toker ME. Early Post-Operative Results of Patients Undergoing Coronary Endarterectomy in Addition to Coronary Artery Bypass Grafting Surgery. Koşuyolu Heart J 2026;29(1):26–33

Address for Correspondence: Alizamin Yusifli

Department of Cardiovascular Surgery, Medicana International Hospital, İzmir, Türkiye

E-mail: dr.alizamin.yusifli@gmail.com

Submitted: November 19, 2025
Revised: December 14, 2025
Accepted: January 08, 2026
Available Online: March 18, 2026

Koroner Arter Baypas Greftleme Ameliyatına Ek Olarak Koroner Endarterektomi Yapılan Hastaların Ameliyat Sonrası Erken Dönem Sonuçları

Özet

Amaç: Koroner arter hastalığının (KAH) tedavisinde koroner arter baypas greftleme (KABG) operasyonu en önemli tedavi yöntemlerinden biri olarak önemini korumaktadır. Bu cerrahinin temel amaçlarından biri de komplet revaskülarizasyonu sağlamaktır. Diffüz veya yaygın koroner arter hastalığı olanlarda KABG operasyonu tam revaskülarizasyonu sağlamakta yetersiz kalabilir. Bu durumda koroner endarterektomi (KE) bir tedavi seçeneği olabilir. Çalışmamızdaki amacımız koroner arter baypas greftleme ameliyatına ek olarak koroner endarterektomi uygulanan hastaların postoperatif erken dönem mortalite ve morbidite sonuçları ve koroner endarterektomi işleminin bu sonuçlara etkisini araştırmaktır.

Yöntem: Çalışmamıza 01.01.2017 ile 31.12.2021 tarihleri arasında koroner arter baypas greftleme ameliyatına ek olarak koroner endarterektomi yapılmış olan 183 hasta dahil edilmiştir. Çalışmamıza izole KABG hastaları dahil edilmiş olup, beraberinde ek bir prosedür uygulanan hastalar, redo cerrahiler çalışma dışı bırakılmıştır. Hastaların

verileri retrospektif olarak incelenmiş olup, hastane veri tabanı, arşiv kayıtları ve hasta dosyaları incelenmiştir. Hastaların preoperatif, intraoperatif ve postoperatif verileri incelenmiştir.

Bulgular: Çalışma; yaşları 30 ile 85 arasında değişmekte olan, 139'u (%76) erkek ve 44'ü (%24) kadın olmak üzere toplam 183 olgu ile yapılmıştır. Olguların %13,1'inde erken dönem postoperatif Mİ, %8,7'sinde erken mortalite görülmüştür.

Sonuç: Diffüz koroner arter hastalığı olan olgularda tam revaskülarizasyonu sağlamak amacıyla koroner endarterektomi efektif bir yöntem olup, yaygın hastalıklı koroner arterde anastomoz için uygun alanın bulunmadığı durumlarda uygulanması gereken bir tekniktir.

Anahtar sözcükler: Koroner arter baypas greftleme; koroner arter hastaliği; koroner endarterektomi.

Introduction

Coronary artery disease (CAD) still ranks among the leading causes of death today. Coronary artery bypass grafting (CABG) surgery remains one of the most vital treatment methods in managing this disease. One of the main goals of this surgery is to achieve complete revascularization. Incomplete revascularization is associated with increased perioperative and post-operative mortality.

Diffuse or widespread CAD is characterized by complete or near-complete occlusion of the coronary artery lumen, involving a substantial length of the vessel.

Such patients are typically deemed unsuitable for percutaneous coronary intervention and being unlikely to benefit from non-surgical treatments, are consequently referred for surgical intervention. In these patients, the CABG procedure may prove insufficient in achieving complete revascularization. In such cases, coronary endarterectomy (CE) may emerge as a viable treatment option. CE is a technique employed when no suitable area for anastomosis can be found in diffusely diseased coronary arteries. CE was first performed by Charles Bailey in 1957; however, successful outcomes could not be achieved due to its inability to be combined with coronary bypass.[1]

The aim of our study is to investigate the early post-operative mortality and morbidity outcomes in patients undergoing CABG combined with CE, and to assess the impact of the endarterectomy procedure on these outcomes.

Materials and Methods

Patient Selection

Our study included 183 patients who underwent CE in addition to CABG between January 1, 2017, and December 31, 2021. Only patients who underwent isolated CABG were included, while those who underwent additional procedures or redo surgeries were excluded from the study. The patients' data were reviewed retrospectively through analysis of the hospital database, archival records, and patient files. Pre-operative, intraoperative, and post-operative data of the patients were thoroughly examined. In the pre-operative evaluation of the patients, age, gender, height, weight, body mass index (BMI), ejection fraction (EF), presence of diabetes mellitus (DM), presence of renal dysfunction, troponin levels, and history of pre-operative myocardial infarction (MI) were assessed. In the intraoperative evaluation of the patients, the number of vessels bypassed, the coronary arteries subjected to endarterectomy, and the number of endarterectomies performed were analyzed. In the post-operative evaluation of the patients, prolonged intubation, development of post-operative renal dysfunction, neurological events, surgical revision, troponin levels on days 1, 2, and 3, need for intra-aortic balloon pump (IABP), need for extracorporeal membrane oxygenation (ECMO), and 30-day mortality were examined. In our study, DM was defined as a fasting blood glucose level of 126 mg/dL or higher; prolonged intubation was defined as remaining intubated for 48 h or more; and renal dysfunction was defined as a creatinine level of 1.2 mg/dL or higher in female patients and 1.4 mg/dL or higher in male patients. Neurological events were defined by criteria, including failure to regain consciousness post-operatively, lack or limitation of cooperation, motor deficits, muscle strength discrepancies between extremities, and the presence of infarction or hemorrhage findings on brain tomography. Patients with a left ventricular EF of 35% or lower were analyzed as a separate group. Patients aged 70 years and older were analyzed as a separate group. Patients with a BMI of 30 or above were analyzed as a separate group.

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and has been approved by the Ethics Committee decision numbered 2022/3/564 dated February 08, 2022.

Surgical Method

The heart was accessed through median sternotomy under general anesthesia. Arterial cannulation was performed through the aorta, and unicaval two-stage venous cannulation was carried out through the right atrial appendage. An antegrade cardioplegia cannula and a vent cannula were inserted through the aorta. In certain cases, a retrograde cardioplegia cannula was advanced into the coronary sinus through the right atrium. An aortic cross-clamp was applied. Cardiac arrest was induced using hyperkalemic isothermic blood cardioplegia administered through the antegrade route. Myocardial protection was maintained by administering antegrade cardioplegia every 20 min and, in some cases, continuously through the retrograde route. Mild systemic hypothermia (30–32°C) was applied in all cases. Following the removal of the cross-clamp and the achievement of adequate hemodynamic stability, cardiopulmonary bypass was terminated. After ensuring hemostasis, the sternum was wired, the subcutaneous tissue and skin were closed appropriately, and the patient was transferred to the intensive care unit.

CE Technique

Both open and closed techniques were employed in performing CE. In patients undergoing the closed endarterectomy technique, a coronary arteriotomy of approximately 1 cm was per-

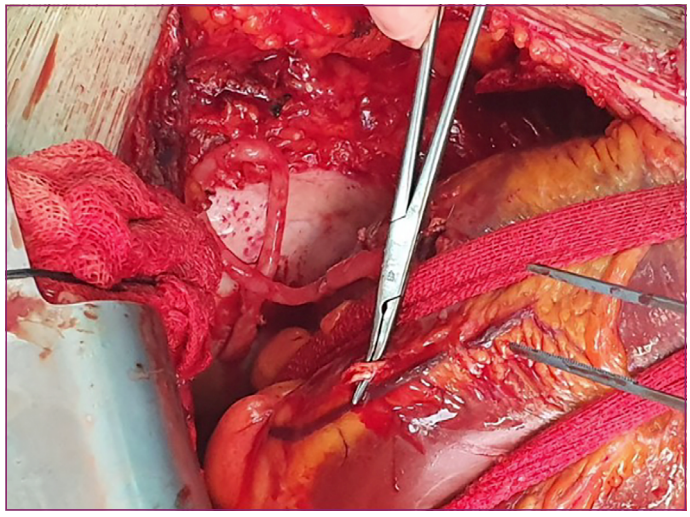

Figure 1. Endarterectomy procedure.

Figure 2. Left anterior descending artery endarterectomy.

Figure 3. Right coronary artery endarterectomy.

formed. The plaque was dissected, and a cleavage was created from the outer third of the media layer, allowing the intraluminal plaque to be gently extracted with slight traction (Fig. 1). In patients undergoing the open endarterectomy technique, the arteriotomy was extended along the plaque-laden segment until healthy vessel wall was reached. A cleavage was created from the outer third of the media layer, and the intraluminal plaque was extracted (Figs. 2, 3).

Table 1. Pre-operative characteristics

Pre-operative	Min-Max	Mean±SD
Age (year)	30–85	59.96±9.33
Height (cm)	145–185	167.26±8.1
Weight (kg)	50–110	79.69±12.81
BMI (kg/m^2)	19.28–41.53	28.52±4.37
EF	20–65	54.21±12.2
Troponin	0.001–3.01	0.17±0.45
	n	**Percentage**
Gender		
Male	139	76
Female	44	24
BMI		
<30	121	66.1
>30	62	33.9
EF		
>35	158	86.3
<35	25	13.7
Diabetes		
–	64	35
+	119	65
Renal dysfunction		
–	175	95.6
+	8	4.4

Min-Max: Minimum-Maximum; SD: Standard deviation; BMI: Body mass index; EF: Ejection fraction.

Statistical Analysis

This study is retrospective in nature. The data were analyzed using the IBM statistical package for the social sciences Statistics 22 software statistical package program (IBM Corp., Armonk, New York, USA). The conformity of the parameters to a normal distribution was assessed using the Kolmogorov–Smirnov and Shapiro–Wilks tests. While evaluating the study data, in addition to descriptive statistical methods (mean, standard deviation, frequency), the Mann–Whitney U test was used for comparisons between two groups for quantitative data that did not show normal distribution. For the comparison of qualitative data, Fisher's Exact Chi-Square test and the Continuity (Yates) Correction were utilized. Logistic regression analysis was employed for multivariate analysis. A significance level of $p<0.05$ was considered statistically significant.

Results

The study was conducted with a total of 183 patients, consisting of 139 (76%) males and 44 (24%) females, aged between 30 and 85 years. A total of 205 endarterectomy procedures were performed in conjunction with CABG among the 183 patients. The mean age of the cohort was 59.96±9.33 years (Table 1). Left anterior descending (LAD) endarterectomy was performed in 56.8% of cases. The intraoperative characteristics of the pa-

Table 2. Intraoperative data

Intraoperative	n	Percentage
CABG×1	4	2.2
CABG×2	34	18.6
CABG×3	88	48.1
CABG×4	49	26.8
CABG×5	7	3.8
LAD	104	56.8
Diagonal	17	9.3
RCA	50	27.3
CX	34	18.6
1 vessel endarterectomy	162	88.5
2 and more vessels endarterectomy	21	11.5

CABG: Coronary artery bypass grafting; LAD: Left anterior descending artery; RCA: Right coronary artery; CX: Circumflex artery.

Table 3. Post-operative data

Post-operative	n	Percentage
Prolonged intubation	31	16.9
Renal dysfunction	49	26.8
Neurological events	15	8.2
Revision	18	9.8
IABP	38	20.8
ECMO	7	3.8
Early mortality	16	8.7
Troponin	**Min-Max**	**Mean±SD**
1 day	0.12-15.7	1.84±2.65
2 day	0.06–48.1	2.28±5.06
3 day	0.02–30	1.51±2.94

IABP: Intra-aortic balloon pump, ECMO: Extracorporeal membrane oxygenator, Min-Max: Minimum-Maximum; SD: Standard deviation

tients are presented in Table 2. In the post-operative period (Table 3), prolonged intubation was observed in 16.9% of cases. Early mortality occurred in 8.7% of cases. Table 4 illustrates the impact of the pre-operative data evaluated on early mortality. Table 5 analysis of the intraoperatively examined data's impact on early mortality indicated that neither the type nor the number of coronary arteries subjected to endarterectomy, nor the number of vessels involved in bypass surgery, demonstrated a statistically significant difference. In Table 6, the effect of post-operative variables on early mortality was investigated. The results found to be statistically significant were further analyzed using multivariate logistic regression (Table 7).

When we evaluated the effects of prolonged intubation, renal dysfunction, neurological event, revision, IABP, ECMO, and troponin levels on days 1, 2, and 3 on early mortality using backward stepwise logistic regression analysis, the model was found to be significant ($p<0.001$), with a Nagelkerke R square value of 0.511, and the model's explanatory power was observed to be at a good level (94.4%).

Table 4. Evaluation of the impact of pre-operative characteristics on early mortality

	Early mortality		p
	–	+	
	n (%)	n (%)	
Age (year)			
<70	143 (91.7)	13 (8.3)	[1]0.710
>70	24 (88.9)	3 (11.1)	
Gender			
Male	129 (92.8)	10 (7.2)	[1]0.221
Female	38 (86.4)	6 (13.6)	
BMI			
<30	112 (92.6)	9 (7.4)	[2]0.551
>30	55 (88.7)	7 (11.3)	
EF			
>35	146 (92.4)	12 (7.6)	[1]0.242
<35	21 (84)	4 (16)	
Diabetes			
–	60 (93.8)	4 (6.3)	[2]0.548
+	107 (89.9)	12 (10.1)	
Renal dysfunction			
–	159 (90.9)	16 (9.1)	[1]1.000
+	8 (100)	0 (0)	
Troponin Mean±SD (median)	0.18±0.47 (0.02)	0.08±0.17 (0.02)	[3]0.835

[1]: Fisher's exact test; [2]:Continuity (yates) correction; [3]:Mann Whitney U Test. BMI: Body mass index; EF: Ejection fraction; SD: Standard deviation.

In the model, the effects of renal dysfunction, neurological event, and 2nd-day troponin level were found to be statistically significant ($p<0.05$). The presence of renal dysfunction increased early mortality by 10.303 times, the presence of a neurological event by 12.749 times, and the 2nd-day troponin level by 1.151 times. Although the effect of prolonged intubation on the model was not statistically significant ($p>0.05$), it remained in the model and was observed to increase the risk of early mortality by 4.141 times.

Discussion

CE requires a great deal of technical skill. It is a technique employed when no suitable area for anastomosis can be found in diffusely diseased coronary arteries. The decision for CE can be planned pre-operatively based on angiography images, or it can be decided during surgery if a suitable site for anastomosis cannot be found in cases of diffuse coronary disease. In our series, the decision to perform CE was made during surgery in the vast majority of cases.

In our study, a total of 183 patients who underwent 205 CE procedures between 2017 and 2021 were analyzed. During the same period, a total of 4,663 isolated CABG surgeries were performed. For this period, the rate of CE was 3.92%. According to the literature, this rate varies between 0% and 40%.

Table 5. Evaluation of the impact of intraoperative factors on early mortality

	Early mortality		p
	–	+	
	n (%)	n (%)	
CABG×1			
–	164 (91.6)	15 (8.4)	[1]0.309
+	3 (75)	1 (25)	
CABG×2			
–	135 (90.6)	14 (9.4)	[1]0.740
+	32 (94.1)	2 (5.9)	
CABG×3			
–	88 (92.6)	7 (7.4)	[2]0.673
+	79 (89.8)	9 (10.2)	
CABG×4			
–	121 (90.3)	13 (9.7)	[1]0.564
+	46 (93.9)	3 (6.1)	
CABG×5			
–	161 (91.5)	15 (8.5)	[1]0.479
+	6 (85.7)	1 (14.3)	
LAD end.			
–	72 (91.1)	7 (8.9)	[2]1.000
+	95 (91.3)	9 (8.7)	
Diagonal end.			
–	151 (91)	15 (9)	[1]1.000
+	16 (94.1)	1 (5.9)	
RCA end.			
–	137 (91.9)	12 (8.1)	[1]0.771
+	30 (88.2)	4 (11.8)	
CX end.			
–	18 (85.7)	3 (14.3)	[1]0.503
+	149 (92)	13 (8)	
1 vessel endarterectomy			
–	149 (92)	13 (8)	[1]0.402
+	18 (85.7)	3 (14.3)	
2 and more vessels endarterectomy			
–	164 (91.6)	15 (8.4)	[1]0.402
+	3 (75)	1 (25)	

[1]: Fisher's Exact Test; [2]: Continuity (yates) correction. CABG: Coronary artery bypass grafting; LAD: Left anterior descending artery; RCA: Right coronary artery; CX: Circumflex artery.

Table 6. Evaluation of the impact of post-operative characteristics on early mortality

	Early mortality		p
	–	+	
	n (%)	n (%)	
Prolonged intubation			
–	149 (98)	3 (2)	[1]0.000*
+	18 (58.1)	13 (41.9)	
Renal dysfunction			
–	131 (97.8)	3 (2.2)	[1]0.000*
+	36 (73.5)	13 (26.5)	
Neurological events			
–	160 (95.2)	8 (4.8)	[1]0.000*
+	7 (46.7)	8 (53.3)	
Revision			
–	156 (94.5)	9 (5.5)	[1]0.000*
+	11 (61.1)	7 (38.9)	
IABP			
–	140 (96.6)	5 (3.4)	[1]0.000*
+	27 (71.1)	11 (28.9)	
ECMO			
–	164 (93.2)	12 (6.8)	[1]0.001*
+	3 (42.9)	4 (57.1)	
1-day Troponin Mean±SD (median)	1.68±2.43 (0.82)	3.51±4.06 (1.96)	[2]0.003*
2-day TroponinMean±SD (median)	1.85±3,63 (0.76)	7.41±12.45 (2.71)	[2]0.001*
3-day Troponin Mean±SD (median)	1.38±2.91 (0.57)	3.38±2.75 (2.43)	[2]0.001*

[1]: Fisher's Exact Test; [2]: Mann Whitney U Test; *: p<0.05. IABP: Intra-aortic balloon pump; ECMO: Extracorporeal membrane oxygenator; SD: Standard deviation.

The wide variability in this rate can be attributed to the lack of a clearly defined indication for CE, with the decision often varying between surgeons, and even among different surgeons within the same center. It is also influenced by the surgeon's preference for CE and their experience with the procedure.[2,3]

Our study was conducted with a total of 183 cases, consisting of 139 men (76%) and 44 women (24%), aged between 30 and 85 years. The mean age was 59.96±9.33 years, yielding results consistent with the literature.

In our study, when examining the impact of pre-operative variables, such as age, gender, BMI, EF, and DM on early mortality, the results obtained from our study did not reveal any statistically significant differences (p>0.05). Upon reviewing the literature, we found that many publications reached results similar to ours, while some presented statistically significant findings. In the study conducted by Fernando A et al.,[4] involving 353 cases, female gender, the presence of DM pre-operatively, and an EF below 35% were found to be associated with early mortality. In the study conducted by Tiruvoipati R et al.,[5] involving 461 cases, age over 70, female gender, pre-operative presence of DM, presence of peripheral artery disease, and an EF below 30% were found to be associated with early mortality.

In our study, a total of 205 CE procedures were performed across the 183 cases examined. Endarterectomy was performed on the LAD in 56.8% of cases (n=104), the Right coronary artery (RCA) in 27.3% (n=50). A review of various studies in the literature

Table 7. Logistic regression analysis results of the parameters found to have a significant effect on early mortality

	OR	%95 CI		p
		Lower limit	Upper limit	
Prolonged intubation	4.141	0.745	23	0.104
Renal dysfunction	10.303	1.306	81.299	0.027*
Neurological events	12.749	2.284	71.151	0.004*
Troponin 2 day	1.151	1.012	1.308	0.032*

Parameters included in the model: Stent, prolonged intubation, renal dysfunction, neurological events, revision, IABP, ECMO, 1.-2.-3.day troponin. *: p<0.05. OR: Odds Ratio; CI: Confidence interval; IABP: Intra-aortic balloon pump; ECMO: Extracorporeal membrane oxygenator.

reveals that the rate of RCA endarterectomy is higher compared to other vessels in many of the analyzed series.[2,4–11] Particularly in recently published series, the rate of LAD endarterectomy has been reported to be higher.[12–15] This can be explained as follows: Over the past two decades, as the safety of CE, particularly the open technique performed on the LAD, has increasingly been reported, LAD CE has become a more confidently preferred approach among surgeons. Similarly, in our study, the rate of LAD endarterectomy was also found to be higher.

Early mortality was observed in 8.7% of patients with LAD endarterectomy and 8.9% of those without; 5.9% of patients with diagonal endarterectomy and 9% of those without; 11.8% of patients with RCA endarterectomy and 8.1% of those without; and 8% of patients with Circumflex artery (CX) endarterectomy and 14.3% of those without. No statistically significant differences were found among these groups (p>0.05). A review of the literature shows that, similar to our findings, many studies have found no association between the specific vessel undergoing endarterectomy and early mortality. However, some publications have demonstrated a significant association. Djalilian et al.,[11] in their series of 64 cases, demonstrated that LAD endarterectomy carries a higher operative risk compared to RCA endarterectomy. Livesay et al.,[2] in their series of 3,369 cases published in the 1980s, reported a mortality rate of 8.5% following LAD endarterectomy, compared to a combined rate of 4.2% following RCA and CX endarterectomies. In the publication by Sirivella et al.,[6] involving 1,478 cases, the reported mortality rates were 1.2% following LAD endarterectomy, 1.4% after RCA endarterectomy, 2.1% after CX endarterectomy, and 6.36% following diagonal endarterectomy. In our series, 88.5% of cases (n=162) underwent single-vessel endarterectomy, while 11.5% (n=21) underwent double or multiple endarterectomies. Early mortality was observed in 8% of single-vessel cases and 14.3% of multi-vessel cases, with no statistically significant difference between the groups (p>0.05). Upon reviewing the literature, we encounter similar findings. In the study conducted by Marzban et al.,[7] involving 310 cases, the single-vessel CE group (87.4%) and the double-vessel CE group (12.6%) were compared, with reported mortality rates of 3.3% and 10.3%, respectively. In the study by Brenowitz et al.,[16] involving 2,501 cases, single and multiple CE groups were compared, with reported mortality rates of 6.3% and 10.4%, respectively. In the series by Sirivella et al.,[6] involving 1,478 cases, the mortality rates for single-vessel CE (63%) and multiple-vessel CE (37%) were reported as 1.8% and 5.5%, respectively. Although all three publications reported numerical differences in mortality rates between the single and multiple CE groups, none of them found these differences to be statistically significant. In our study, the post-operative data revealed that prolonged intubation occurred in 16.9% of cases, renal dysfunction in 26.8%, neurological events in 8.2%, surgical revision in 9.8%, need for IABP insertion in 20.8%, and need for ECMO insertion in 3.8% of patients. Early post-operative MI was observed in 13.1% of cases, and early mortality occurred in 8.7% of the patients. A review of the literature reveals findings similar to ours: Tiruvoipati R et al.[5] reported a mortality rate of 8.6% in their series of 461 cases while Fernando A et al.[4] reported a mortality rate of 9.3% and a post-operative MI rate of 13.6% in their series of 353 cases. A broader review of the literature shows that post-endarterectomy mortality rates range from 0% to 15%, while MI rates vary between 5% and 25%.[3,4,14,17] In their study, Toker et al.[12] found a mortality rate of 4.2% following CE, compared to 4.8% in the control group that underwent isolated CABG without CE, and concluded that there was no significant difference in early mortality between the two groups. Byrne et al.,[18] in their series of 196 cases, reported early mortality at 3%, perioperative MI at 3%, prolonged intubation at 8%, neurological events at 6%, renal dysfunction at 3%, IABP insertion at 10%, and revision surgery at 3.2%, Marinelli et al.,[14] in a series of 107 patients, reported early mortality at 4.7%, perioperative MI at 1.9%, prolonged intubation at 1.9%, neurological events at 0.9%, renal dysfunction at 3.7%, IABP insertion at 5.6%, and revision at 1.9%, Yener et al.,[10] in a series of 587 cases, reported early mortality at 1.3%, perioperative MI at 10.4%, prolonged intubation at 3.9%, neurological events at 0.85%, renal dysfunction at 0.17%, IABP insertion at 7.3%, and revision at 1.1%.Although our rates of early mortality and perioperative MI were consistent with the literature, these rates are high for elective coronary artery bypass surgery without endarterectomy. We believe this situation may be related to the fact that coronary arteries with an indication for endarterectomy have diffuse disease, and these patients have a higher comorbidity rate compared to elective CABG patients who do not require endarterectomy.

In our study, when investigating the impact of post-operative variables on early mortality, multivariate logistic regression analysis identified post-operative renal dysfunction, post-operative neurological events, and the troponin level on post-operative day 2 as factors associated with early mortality. The early mor-

tality rate was significantly higher in patients with renal dysfunction (26.5%) compared to those without (2.2%) (p=0.000; p<0.05). The presence of renal dysfunction increased the risk of early mortality by 15.769 times (confidence interval [CI]: 4.261–58.350). The early mortality rate was significantly higher in patients who experienced neurological events (53.3%) compared to those who did not (4.8%) (p=0.000; p<0.05). The presence of a neurological event increased the risk of early mortality by 22.857 times (CI: 6.626–78.844). The day 2 troponin level was significantly higher in patients who experienced early mortality compared to those who did not (p=0.001; p<0.05). Elevated troponin levels on the second post-operative day increased the risk of early mortality by 1.111 times (CI: 1.023–1.206). A review of the literature shows that in the study by Fernando A et al.,[4] involving 353 cases, post-operative use of IABP (13.03%), perioperative MI (13.6%), revision surgery (6.52%), and, in alignment with our findings, the development of post-operative renal dysfunction were all associated with early mortality. In summary, our study's multivariate logistic regression analysis revealed that post-operative renal failure, post-operative neurological events, and the troponin level on the second post-operative day were significantly associated with early mortality. In addition, none of the pre-operative patient characteristics were identified as factors increasing early mortality in this analysis. Furthermore, neither the target vessel nor the number of endarterectomies performed was identified as a risk factor associated with mortality. Considering the pre-operative patient characteristics, our patient population appears to be at higher risk compared to those in isolated CABG series. Our early mortality rate is 8.7%. Considering that 65% of our patients (n=119) were diabetic, 13.7% (n=25) had an EF of 35% or lower, and 33.9% (n=62) had a BMI of 30 or above, and in light of the literature, this rate is within an acceptable range.

Study Limitations

This study was a retrospective observational study performed at a single institution. Our study covered a period of 5 years and the number of patients was 183; thus results might be biased. Study time interval and a low number of patients may adversely affect the study.

Conclusion

Many patients with diffuse vessel disease and a surgical indication are approached with caution by numerous surgeons and centers, often leading to avoidance of surgical intervention. We believe that in such cases, where the distal vessel bed demonstrates antegrade or retrograde filling on angiography, CE should not be avoided. We believe that in coronary circulation, regardless of which vascular system is involved, CE should be performed intraoperatively to achieve complete revascularization in cases where the diffuse, hard, and calcified plaque is encountered. In conclusion, CE is an effective method for achieving complete revascularization in patients with diffuse CAD, and it is a technique that should be employed when no suitable area for anastomosis can be found in extensively diseased coronary arteries.

Disclosures

Ethics Committee Approval: The study was approved by the Koşuyolu High Training and Research Hospital Clinical Research Ethics Committee (no: 2022/3/564, date: 08/02/2022).

Informed Consent: Retrospective study.

Conflict of Interest Statement: All authors declared no conflict of interest.

Use of AI for Writing Assistance: No AI technologies utilized.

Funding: The authors declared that this study received no financial support.

Author Contributions: Concept – A.Y., M.E.T.; Design – A.Y., M.E.T. ; Supervision – A.Y., M.E.T.; Funding – A.Y., M.E.T.; Materials – A.Y.; Data collection and/or processing – A.Y.; Data analysis and/or interpretation – A.Y., M.E.T.; Literature search – A.Y.; Writing – A.Y., M.E.T.; Critical review – A.Y., M.E.T.

Peer-review: Externally peer-reviewed.

References

1. Bailey CP, May A, Lemmon WM. Survival after coronary endarterectomy in man. J Am Med Assoc 1957;164:641–6.
2. Livesay JJ, Cooley DA, Duncan JM, Ott DA, Frazier OH, Hallman GL, et al. Early and late results of coronary endarterectomy in 3,369 patients. Adv Cardiol 1988;36:27–33.
3. Ulular Ö, Eren E, Özışık K. Atan kalpte yapılan koroner endarterektomilerin orta dönem anjiyografik sonuçları. Turkiye Klinikleri J Cardiovasc Sci 2010;22:213–9. [Article in Turkish]
4. Atik FA, Dallan LA, de Oliveira SA, Lisboa LA, Platania F, Cabral RH, et al. Myocardial revascularization with coronary endarterectomy. Stratification of risk factors for early mortality. Arq Bras Cardiol 2000;75:269–80.
5. Tiruvoipati R, Loubani M, Lencioni M, Ghosh S, Jones PW, Patel RL. Coronary endarterectomy: impact on morbidity and mortality when combined with coronary artery bypass surgery. Ann Thorac Surg 2005;79:1999–2003.
6. 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;80:1738–44.
7. Marzban M, Karimi A, Ahmadi H, Davoodi S, Abbasi K, Movahedi N, et al. Early outcomes of double-vessel coronary endarterectomy in comparison with single-vessel coronary endarterectomy. Tex Heart Inst J 2008;35:119–24.
8. LaPar DJ, Anvari F, Irvine JN Jr, Kern JA, Swenson BR, Kron IL, et al. The impact of coronary artery endarterectomy on outcomes during coronary artery bypass grafting. J Card Surg 2011;26:247–53.
9. Schmitto JD, Kolat P, Ortmann P, Popov AF, Coskun KO, Friedrich M, et al. Early results of coronary artery bypass grafting with coronary endarterectomy for severe coronary artery disease. J Cardiothorac Surg 2009;4:52.
10. Yener AÜ, Kervan Ü, Korkmaz K, Gedik HS, Budak AB, Genç SB. The impact of coronary artery endarterectomy on mortality and morbidity during coronary artery bypass grafting. Turk J Thorac Cardiovasc Surg 2014;22:734–41.
11. Djalilian AR, Shumway SJ. Adjunctive coronary endarterectomy: improved safety in modern cardiac surgery. Ann Thorac Surg 1995;60:1749–54.
12. Toker ME, Özbek B, Çelik S, Demir H, Demir İ. Comparison of isolated coronary artery bypass grafting with open coronary endarterectomy followed by coronary artery revascularization. Turkiye Klinikleri J Cardiovasc Sci 2017;29:42–7.
13. Alreshidan M, Albabtain M, Obied H, Alassal M, Albaradai A, Alghofaili F. Does coronary endarterectomy increase early mortality and morbidity compared with coronary artery bypass surgery alone-single centre experience. International Journal of Clinical Medicine 2014;5:197–205.
14. Marinelli G, Chiappini B, Di Eusanio M, Di Bartolomeo R, Caldarera I, Marrozzini C, et al. Bypass grafting with coronary endarterectomy: immediate and long-term results. J Thorac Cardiovasc Surg 2002;124:553–60.

15. Nishi H, Miyamoto S, Takanashi S, Minamimura H, Ishikawa T, Kato Y, et al. Optimal method of coronary endarterectomy for diffusely diseased coronary arteries. Ann Thorac Surg 2005;79:846–52.
16. Brenowitz JB, Kayser KL, Johnson WD. Results of coronary artery endarterectomy and reconstruction. J Thorac Cardiovasc Surg 1988;95:1–10.
17. Tavlasoğlu M, Kürklüoğlu M, Amrahov A, Jahollari A, Arslan Z, Durukan AB. Koroner endarterektomi uyguladığımız hastalarımızda klinik ve anjiografik sonuçlarımız. Pam Tıp Derg 2012;5:48–56.
18. Byrne JG, Karavas AN, Gudbjartson T, Leacche M, Rawn JD, Couper GS, et al. Left anterior descending coronary endarterectomy: early and late results in 196 consecutive patients. Ann Thorac Surg 2004;78:867–73.