The Impact of Coronary Endarterectomy on Early Outcomes of Coronary Artery Bypass Grafting

Koroner Arter Bypass Cerrahisinde Koroner Endarterektominin Erken Dönem Sonuçlara Etkisi

Ulaş KUMBASAR[1], İlhan ÖZGÖL[2], Ali Can HATEMİ[2], Burcu Işık SUNGUR BİCAKHAN[2], Aybala Tongut[2], Cem BOSTAN[3], Umut KARABULUT[3]

[1] Department of Cardiovascular Surgery, Ahi Evran University Kirsehir State Hospital, Kırşehir-TÜRKİYE

[2] Department of Cardiovascular Surgery, Institute of Cardiology, Istanbul University, İstanbul-İSTANBUL

[3] Department of Cardiology, Institute of Cardiology, Istanbul University, İstanbul-İSTANBUL

Geliş Tarihi: 24.08.2012 Kabul Tarihi:12.11.2012

Abstract

Aim:The effects of coronary artery endarterectomy (CE) during coronary artery bypass grafting (CABG) have been debated. In this study we sought to examine the present day early clinical outcomes of patients undergoing CABG with CE compared to patients undergoing CABG alone.

Material And Methods: Patients undergoing isolated CABG operation from 1991 to 2010 were retrospectively reviewed and 69 consecutive patients undergoing isolated CABG with CE were compared with 69 patients undergoing CABG alone.

Results: Pre-operative demographics and risk factors were similar between the groups. The complexity of the procedure in the CE group was associated with longer cardiopulmonary bypass (CPB) time (176.26±51.95 vs. 136.81±43.97 minutes, p=0.0001) and aortic cross-clamp times (104.72±31.29 vs. 75.7±26.78 minutes, p=0.0001). The incidence of major post-operative complications (arrhythmias, myocardial infarction (MI), cerebrovascular accident (CVA), infectious and pulmonary complications), post-operative total drainage, intubation time, intensive care unit (ICU) and hospital stay times were also similar between the groups. There was a higher incidence of intra aortic balloon pump (IABP) insertion in patients undergoing CE compared to CABG alone (5.8% vs. 0%, p=0.042).

Conclusion: The operative mortality and major morbidity in the CE group were comparable to CABG alone. Therefore, CE should be considered an acceptable adjunct to CABG for patients with end stage coronary disease to achieve complete revascularization.

Keywords: Coronary artery, endarterectomy, by-pass grafting

Özet

Amaç: Koroner arter bypass cerrahisi (KABC) esnasında koroner endarterektominin (KE) etkileri konusu tartışmalıdır. Bu çalışma sadece KABC uygulanan hastalarla KE ile eş zamanlı KABC uygulanan hastalarin erken klinik sonuçlarını karşılaştirmayi amaçlar.

Yöntem ve Gereçler: KABC ile eşzamanlı KE uygulanan 69 hasta ile sadece KABC uygulanan 69 hasta karşılaştırılmıştır.

Bulgular: Karşılaştırılan gruplar arasinda operasyon öncesi yapılan test sonuçları, demografik özellikler ve risk faktörleri benzerdir. KE grubunda prosedürün kompleks olmasından dolayı kardiyopulmoner bypass (176.26±51.95 vs. 136.81±43.97 dakika, p=0.0001) ve aort klemp süresi (104.72±31.29 vs. 75.7±26.78 dakika, p=0.0001) daha uzun-

dur. Major postoperatif komplikasyonların (Aritmiler, miyokard infarktüsü, serebrovasküler olay, enfeksiyöz ve pulmoner) insidansı, postoperatif total drenaj miktarı, entübasyon zamanı, yoğun bakım ve hastanede kalış süreleri gruplar arasında benzerdi. KE grubunda intraaortik balon pompası uygulanması daha sık görüldü (5.8% ve 0%, p=0.042).

Sonuç: KE grubunda operatif mortalite ve morbidite sadece KABC uygulanan grupla karşılaştırılabilir düzeydedir. Bu nedenle, ileri evre koroner arter hastalığı olan hastalarda komplet revaskülarizasyonun yapılabilmesi için KE kabul edilebilir ve uygulanabilir bir alternatiftir.

Anahtar Kelimeler: Koroner arter, endarterektomi, bypass greft.

Introduction

The spectrum of patients referred for coronary artery bypass graft (CABG) surgery is increasingly more complex with multiple comorbidities including hypertension, diabetes mellitus, cigarette smoking, cerebral and peripheral vascular disease, renal dysfunction and chronic pulmonary disease. In addition, many patients have undergone previous catheter-based interventions which increases the number of patients present with complex anatomy, advanced stage and diffuse coronary artery disease. The adverse effect of incomplete myocardial revascularization on short and long-term outcomes is well known (1-3). Thus, complete revascularization should be the most important goal of CABG (2,4). However, complete revascularization using conventional CABG may not be feasible due to diffuse disease. In this selected group of patients, coronary endarterectomy (CE) should be considered as an adjunct to CABG to achieve complete revascularization.

While early experiences with CE reported higher rates of peri-operative mortality (3.2%-10%), and myocardial infarction (MI) (4%-%15), more recent data suggest that it can be performed safely with good early results (5-7). The purpose of this study is to examine the present day early clinical outcomes of patients undergoing CABG with CE compared to patients undergoing CABG alone.

Material And Methods

Sixty-nine consecutive patients undergoing isolated CABG with CE at Istanbul University, Institute of Cardiology between June 1991 and July 2010 were compared with 69 patients undergoing CABG alone. Patients having combined valve and CABG or CE or other concomitant procedures were excluded.

Surgical Technique: All operations were performed using cardiopulmonary bypass (CPB) with moderate hypothermia (27°C to 32°C) and standard systemic anticoagulation. Myocardial protection was achieved using cold antegrade and retrograde blood cardioplegia supplemented by topical cooling with cold (4°C) saline. Distal anastomoses were constructed during a single aortic cross-clamp period. Saphenous vein and internal mammary artery (IMA) were used for grafts.

All vessels undergoing endarterectomy were diffusely diseased and were poor candidates for distal bypass anastomosis. Coronary endarterectomy was performed in vessels with a pre-endarterectomy outer diameter of 1.5 mm or greater, supplying viable muscle with evidence of reversible ischemia. The "open" technique was used in most cases. In the left anterior descending (LAD) territory, the proximal extent of the endarterectomy was limited not to jeopardize the septal perforators (8-10). In most cases, the bypass conduit was directly anastomosed to the endarterectomy site. All endarterectomy patients were treated postoperatively with aspirin and warfarin sodium for a minimum of six months. Conventional CABG patients receive only aspirin.

Data Collection: The study was approved by the Ethics Committee of the Institute of Cardiology, Istanbul University and all patients enrolled in the study gave written informed consent. Data include demographics, risk factors and comorbidities, intraoperative details, and postoperative complications. Recent MI and remote MI were defined as MI occurring within 1 month pre-operatively and more than 1 month pre-operatively respectively. Peri-operative MI was defined as a creatine kinase myocardial band (CK-MB) level ≥ 5 times the upper limit of normal within the first 24 postoperative hours or by the presence of at least one of the following after more than 24 postoperative hours during the same hospitalization: evolutionary ST-segment elevations, development of new Q waves in two continuous ECG leads, new left bundle branch block, or a CK-MB level of ≥ three times the upper limit of normal. Operative mortality was defined as a death occurring within 30 days of operation or during the same hospitalization if longer. Left ventricular ejection fraction (LVEF) was classified as good (>50%), moderate (30-50%) and poor (<30%).

Statistical Analysis

Data are expressed as means ± SD. Statistical analysis was performed using the SPSS statistical package version 14.0 software for Windows (SPSS, Inc., Chicago, IL, USA). The suitability of continuous variables to normal distribution

was tested by the Kolmogorov-Smirnov test and data were analyzed using the Student's t-test (parametric data) and Mann-Whitney U test (non-parametric data). Discrete variables (categorical) were analyzed using the chi-square-test. P-value less than 0.05 was considered statistically significant.

Results

Patient demographics and pre-operative characteristics are depicted in Table 1. There were no significant differences in pre-operative demographics and risk factors between the two groups, with the exception of pre-operative hypertension which was detected more frequent among patients undergoing CE compared to those undergoing CABG alone (62.5% vs. 46.4%, p=0.026).

Table I. Patient Characteristics.

	CE (n = 69)	Control (n = 69)	p Value
Age (years)	56±10.3	58±10.3	0.052
Gender (M/F)	51/18	51/18	1.000
Body mass index (kg/m²)	27±4.2	26±3.4	0.461
Hypertension	45 (65.2%)	32 (46.4%)	0.026
Diabetes mellitus	28 (40.6%)	32 (46.4%)	0.492
Smoking	50 (72.5%)	41 (59.4%)	0.106
Hypercholesterolemia	31 (44.9%)	38 (55.1%)	0.233
Remote MI	27 (39.1%)	34 (49.3%)	0.230
Recent MI	13 (18.8%)	11 (15.9%)	0.653
Prior CVA	7 (10.1%)	2 (2.9%)	0.085
COPD	4 (5.8%)	6 (8.7%)	0.511
Peripheral vascular disease	4 (5.8%)	3 (4.3%)	0.698
Arrhythmia (AF and/or VT)	2 (2.9%)	5 (7.2%)	0.245
LVEF			1.000
Good	34 (49.3%)	34 (49.3%)	
Moderate	34(49.3%)	34(49.3%)	
Poor	1 (1.4%)	1 (1.4%)	
Angiographic findings			
Number of vessels diseased			0.758
Three-vessel disease	46 (66.7%)	46 (66.7%)	
Double-vessel disease	21 (30.4%)	17 (25.8%)	
Single-vessel disease	2 (2.9%)	3 (4.3%)	
Left main disease	9 (13%)	18 (26.1%)	0.053

MI: myocardial infarction, CVA: cerebrovascular accident, COPD: chronic obstructive pulmonary disease, AF: atrial fibrillation, VT: ventricular fibrillation, LVEF: left ventricular ejection fraction.

Operative Data: Operative data are summarized in Table 2. The complexity of the procedure in the CE group was associated with longer CPB time (176.26±51.95 vs. 136.81±43.97 minutes, p=0.0001) and aortic cross-clamp times (104.72±31.29 vs. 75.7±26.78 minutes, p=0.0001). Number of proximal anastomoses performed was similar between the groups. In CE group left internal mammary artery (LIMA) was used in 89.9%, right internal mammary artery (RIMA) was used in 17.4% of patients (p=0.085) whereas in CABG alone group LIMA was used in 97.1% and RIMA was used in 26.1% of patients (p=0.216).

Table II. Operative Data

	CE (n = 69)	Control (n = 69)	p Value
LIMA graft	62 (89.9%)	67 (97.1%)	0.085
RIMA graft	12 (17.4%)	18 (26.1%)	0.216
Other arterial grafts	0 (0%)	3 (4.3%)	0.080
Number of proximal anastomoses			0.446
0	1 (1.4%)	0 (0%)	
1	19 (27.5%)	16 (25.4%)	
2	27 (39.1%)	33 (52.4%)	
3	19 (27.5%)	13 (20.6%)	
4	3 (4.3%)	1 (1.4%)	
LIMA graft to LAD	55 (79.7%)	54 (78.3%)	0.834
RIMA graft to LAD	4 (5.8%)	11 (15.9%)	0.056
CPB time (min)	176.26±51.95	136.81±43.97	0.0001
Aortic cross-clamp time (min)	104.72±31.29	75.7±26.78	0.0001

LIMA: left internal mammary artery, RIMA: right internal mammary artery, LAD: left anterior descending, CPB: cardiopulmonary bypass

Post-operative Complications: Post-operative complications and outcomes are presented in Table 3. Operative mortality was same between the two groups (2.9%). The incidence of major post-operative complications including arrhythmias, MI, CVA, infectious and pulmonary complications and exploration for bleeding were similar between the groups. Post-operative total drainage, intubation time, ICU and hospital stay times were also similar between the groups. There was a higher incidence of IABP insertion in patients undergoing CE compared to CABG alone (5.8% vs. 0%, p=0.042).

Table III. Post-operative outcomes

	CE (n = 69)	Control (n = 69)	p Value
Atrial arrhythmia	11 (15.9%)	17 (24.6%)	0.204
Ventricular arrhythmia	7 (10.1%)	11 (15.9%)	0.312
AV/L-R bundle block	1 (1.4%)	2 (2.9%)	0.559
Exploration for bleeding	2 (2.9%)	4 (5.8%)	0.404
Post-op MI	2 (2.9%)	1 (1.4%)	0.559
Post-op CVA	2 (2.9%)	1 (1.4%)	0.559
Infectious complications	2 (2.9%)	2 (2.9%)	1.000
Sternal dehiscence	1 (1.4%)	0 (0%)	0.316
Side branch	13 (18.8%)	5 (7.2%)	0.043
Wound infection	5 (7.2%)	3 (4.3%)	0.466
Pulmonary complications	2 (2.9%)	3 (4.3%)	0.649
IABP insertion	4 (5.8%)	0 (0%)	0.042
Total drainage (ml)	1196.38±61	1256.4±70	0.858
Entubation time (hour)	22.25±16	17.62±8.2	0.062
ICU stay (hour)	87.14±91	70.90±35	0.056
Hospital stay (day)	11.91 ±5.8	10.23 ±2.8	0.067
Mortality	2 (2.9%)	2 (2.9%)	1.000

AV: atrioventricular, MI: myocardial infarction, CVA: cerebrovascular accident, IABP: intra-aortic balloon pump, ICU: intensive care unit

Discussion

Standard CABG techniques cannot be performed in 0.8% to 25.1% of all patients with diffusely diseased coronary arteries (11,12). CE was first described by Baily in 1957 as a method of treating coronary artery disease without CPB and CABG (13). The increased post-operative morbidity and MI rates with high operative mortality reported in the literature dissuaded many surgeons from performing this procedure (6,14,15). However, with the recent trend of treating more cases of diffuse coronary artery disease and increasingly indicated surgical therapy for severely diseased vessels has resulted in a revival of interest in CE (7,16-19). Recent studies show substantially improved clinical outcomes, with mortality and major complication rates that are similar to CABG alone (7,20,21). In this study, the operative mortality of 2.9% in CE group is similar to the operative mortality of 2% to 6% reported by others, and the incidence of post-operative MI of 2.9% in the same group is also similar to 2% to 12% in previous reports (11,20-22).

In this study, decision to perform CE was made intraoperatively. CE was only performed on occluded, nearly occluded and/or calcified vessels, when regular anastomosis between graft and coronary artery seemed to be technically impossible.

The choice of endarterectomy technique is still debatable (8,11,16). The traction technique is simpler, can be performed via a limited arteriotomy, and therefore, easier to reconstruct. Disadvantages of this technique are incomplete removal of the plaque in distal vessels and shearing-off the plaque in side branches which may be particularly detrimental in the LAD territory due to impairment of blood flow in the septal perforators. However, we preferred the open technique which avoids these problems and allows complete removal of the plaque both from the main vessels and side branches under direct vision (8,9,23). Nevertheless, reconstruction often requires a patch to close the vessel in the open technique; therefore, it is more time consuming causing prolonged myocardial ischemic time.

In this study, the time required to perform the endarterectomy itself and fulfill the long-range suture of the vessel resulted in longer CPB and aortic cross-clamp times in the CE group compared with control. Similar observations were made by other investigators (8,11,15,23). Additionally, there was a higher incidence of IABP insertion in the CE group which may be related to prolonged operative times and more diffuse nature of the disease seen in this group. Adversely, pulmonary complications, entubation times, ICU and hospital stay times were similar between the groups in contrast to other studies (7,20,21).

There are some limitations of this study. First, due to small number of patients in each group we are limited in our abilities to detect small differences between the groups. Secondly, our study was limited to hospital outcome and we are unable to assess long-term survival and freedom from MI. Moreover, the patency of the grafts to the endarterectomized vessels was not routinely assessed by follow-up coronary angiographic studies.

This study demonstrates that, despite the higher risk profile, mortality and major complications in the CE group were similar to the control group. These outcomes suggest that CE can be performed with acceptable operative risk. As a result, CABG and adjunctive CE offer a valuable surgical option for patients with end stage coronary artery disease in whom complete revascularization otherwise could not be obtained.

References

1. Schaff HV, Gersh BJ, Pluth JR, Danielson GK, Orszulak TA, Puga FJ, et al. Survival and functional status after coronary artery bypass grafting: results 10 to 12 years after surgery in 500 patients. Circulation 1983;68:200-4
2. Loop FD. Resurgence of coronary artery endarterectomy. J Am Coll Cardiol 1988;11(4): 712-3
3. Parsonnet V, Gilbert L, Gielchinsky I, Bhaktan EK, Atherlay T. Coronary Endarterectomy: An Analysis of Its Role in Aortocoronary Bypass. Cardiovasc Dis 1976;3(1):51-60
4. Lawrie GM, Morris GC, Jr., Silvers A, Wagner WF, Baron AE, Beltangady SS, et al. The influence of residual disease after coronary bypass on the 5-year survival rate of 1274 men with coronary artery disease. Circulation 1982;66(4):717-23
5. 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
6. Minale C, Nikol S, Zander M, Uebis R, Effert S, Messmer BJ. Controversial aspects of coronary endarterectomy. Ann Thorac Surg 1989;48(2):235-41
7. Shapira OM, Akopian G, Hussain A, Adelstein M, Lazar HL, Aldea GS, et al. Improved clinical outcomes in patients undergoing coronary artery bypass grafting with coronary endarterectomy. Ann Thorac Surg 1999;68(6):2273-8
8. Gill IS, Beanlands DS, Boyd WD, Finlay S, Keon WJ. Left anterior descending endarterectomy and internal thoracic artery bypass for diffuse coronary disease. Ann Thorac Surg 1998;65(3):659-62
9. Mills NL. Coronary endarterectomy: surgical techniques for patients with extensive distal atherosclerotic coronary disease. Adv Card Surg 1998;10:197-227
10. 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(3):846-52
11. Brenowitz JB, Kayser KL, Johnson WD. Results of coronary artery endarterectomy and reconstruction. J Thorac Cardiovasc Surg 1988;95(1):1-10
12. Shapira N, Lumia FJ, Gottdiener JS, Germon P, Lemole GM. Adjunct endarterectomy of the left anterior descending coronary artery. Ann Thorac Surg 1988;46(3):289-96
13. Bailey CP, May A, Lemmon WM. Survival after coronary endarterectomy in man. J Am Med Assoc 1957;164(6):641-6
14. Longmire WP, Jr., Cannon JA, Kattus AA. Direct-vision coronary endarterectomy for angina pectoris. N Engl J Med 1958;259(21):993-9
15. Livesay JJ, Cooley DA, Hallman GL, Reul GJ, Ott DA, Duncan JM, et al. Early and late results of coronary endarterectomy. Analysis of 3,369 patients. J Thorac Cardiovasc Surg 1986;92(4):649-60
16. Tasdemir O, Kiziltepe U, Karagoz HY, Yamak B, Korkmaz S, Bayazit K. Long-term results of reconstructions of the left anterior descending coronary artery in diffuse atherosclerotic lesions. J Thorac Cardiovasc Surg 1996;112(3):745-54
17. Abrahamov D, Tamaris M, Guru V, Fremes S, Christakis G, Bhatnagar G, et al. Clinical results of endarterectomy of the right and left anterior descending coronary arteries. J Card Surg 1999;14(1):16-25
18. Asimakopoulos G, Taylor KM, Ratnatunga CP. Outcome of coronary endarterectomy: a case-control study. Ann Thorac Surg 1999;67(4):989-93
19. 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(3):553-60
20. 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
21. 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(3):247-53
22. Goldstein J, Cooper E, Saltups A, Boxall J. Angiographic assessment of graft patency after coronary endarterectomy. J Thorac Cardiovasc Surg 1991;102(4): 539-44; discussion 44-5.
23. Djalilian AR, Shumway SJ. Adjunctive coronary endarterectomy: improved safety in modern cardiac surgery. Ann Thorac Surg 1995;60 (6):1749-54.

Corresponding Author: Ulas KUMBASAR, MD

Department of Cardiovascular Surgery,

Ahi Evran University Kirsehir State Hospital, Kirsehir, TURKEY

Phone: 00 90 533 357 10 75

E-mail: ulaskumbasar@gmail.com