



Original Article

Comparing short and long term survival of patients undergoing off pump coronary artery bypass graft with and without coronary endarterectomy



Feridoun Sabzi, Atefeh Asadmobini*, Mansour Rezaei

Cardiovascular Research Center, Kermanshah University of Medical Sciences, Kermanshah, Iran

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ABSTRACT

Background and aim: There is some controversy about survival of coronary endarterectomy (CE) patients, so the current study aims to compare short and long term survival of patients undergoing off pump coronary artery bypass graft (OPCAB) with and without coronary endarterectomy.

Patients and methods: we performed a retrospective analysis of data on patients undergoing OPCAB and CE between 2011 and 2012. Preoperative, perioperative and postoperative data collected from data bank. Follow-up information was obtained from telephone contact mean time 37.13 ± 23.82 months after surgery. Early and late outcomes were compared by univariate and Kaplan-Meier analysis.

Result: OPCAB was performed in 474 patients, which 69 of them had a CE. The mean long term survival was similar between OPCAB (56.28 ± 0.61) and OPCAB + CE (55.54 ± 1.3) groups ($p = 0.66$). Multiple Cox regression shows that age, gender, BMI, EF and angina were significant predictors of mortality. Patients undergoing CE have a long term intensive care unit (ICU) stay (51.31 ± 5.59 vs 37.23 ± 0.88 , $P = 0.015$) and blood transfusion was higher in CE group (650.62 ± 110 vs. 324.71 ± 22 , $P = 0.001$).

Conclusion: The current study demonstrates that results of CE are acceptable with respect to short and long -term survival. Patients undergoing CE required long term ICU stay and higher blood transfusion.

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1. Introduction

Coronary artery disease (CAD) is a major cause of cardiovascular mortality globally, as well as in Iran.¹ With advance in nonsurgical methods, patients with complex CAD are candidates for coronary artery bypass grafting (CABG).² Coronary endarterectomy (CE) as an adjunct technique to CABG could be used in patient with diffused CAD for receiving complete revascularization.^{3,4}

Today, many surgeons are still reluctant to use CE due to increased postoperative mortality and myocardial infarction (MI) rate compared with CABG alone.³ On the other hand, researchers have recently reported good perioperative outcome with evidence of various results depending on the coronary vessel requiring endarterectomy.⁴

Multi-vessel CE has been described, but the results are not desirable compared with single-vessel left anterior descending (LAD) CE.⁵ Although, CE has become a safe method in recent years, adding second CE dramatically worsen prognosis.³ With further refinement in method, in the past three decades, it has been found that patients treated with CABG and CE had more favorable results than patients treated with CABG alone.^{6–8} Although some studies, mainly since 1990, reported an increased mortality and in-hospital complications after CE.^{9–11} But other studies reported acceptable perioperative results for CE.^{12,13} Marinelli et al., study on 107 patients underwent coronary endarterectomy. Their 72-months follow up showed $91.2\% \pm 4.9\%$ survival rate.⁸ Sirivella et al. reported that 5-year and 10-year survival rate were $83\% \pm 5\%$, and $74\% \pm 3\%$, respectively in CE patients.¹⁴ Tiruvoipati et al., reported higher mortality rate and postoperative complications in patients undergoing CE.¹¹ As mentioned above, there is some controversy in survival of CE patients, therefore, the aims of the current study are comparison between short and long term survival of patients undergoing off pump coronary artery bypass graft with and without coronary endarterectomy.

* Corresponding author at: Shaheed Beheshti Ave., Cardiovascular Research Centre, Imam Ali Hospital, Kermanshah 6715847145, Iran.
E-mail address: a.asadmobini@gmail.com (A. Asadmobini).

2. Patients and methods

2.1. Patient population

A retrospective cohort study of patients was performed in 2011 until 2012. Data were collected from medical record in the Imam Ali Hospital of Kermanshah University of Medical Science data bank. This research was approved by the ethics committee of the Kermanshah University of Medical Sciences. All of the patients operated by a single surgeon. Any patients who had other procedures in addition to CABG such as aortoplasty, valve repair or replacement and left ventricular aneurysm resection were excluded. This population was comprised of 474 patients who had OPCAB surgery. Of these 474 patients 69 of them had CE in addition to OPCAB thus, the patients were divided into two groups, the OPCAB and the OPCAB + CE group.

2.2. Follow-up

All patients were followed up after discharge for a mean follow up of 37.13 ± 23.82 months by telephonic contact.

2.3. Data collection

All variables were based on the Society of EuroScore 2 definitions. A standardized form for data collection included preoperative variable including: age, gender, body mass index (BMI), diabetes mellitus, hypertension, hypercholesterolemia, smoking history, family history of CAD, peripheral vascular disease, congestive heart failure, left ventricular EF, previous myocardial infarction, angina, previous CABG, left main coronary artery diseases. Operative data consisted number of grafts and vessel diseases. Postoperative variables were: MI, arrhythmia, low cardiac output, bleeding, blood transfusion in the intensive care unit (ICU), total length of the ICU stay, and hospital mortality.

2.4. Definitions

Bleeding was considered when they needed reoperation. Hospital mortality was defined as death occurring before discharge from the hospital and death was classified as either cardiac or non-cardiac mortality. Arrhythmia refer to postoperative atrial fibrillation or flutter, heart blockage that required a pacemaker, and ventricular arrhythmias. Myocardial infarction (MI) was defined as elevation of the serum creatinine kinase isoenzyme MB (CK-MB) to 3-times the upper limit of normal, in the absence of new pathological Q-waves.

2.5. Surgical procedure

CE was carried out in severely diseased vessels where conventional CABG was impossible. Although a preoperative prediction for CE can be obtained from the coronary angiogram, the final decision is made intraoperative on the basis of technical considerations. It was not considered complete occlusion on the angiogram as a definite indication for CE. CE was considered when viable myocardium was not suitable for grafting and there is multiple discrete obstructing lesions or diffuse atherosclerosis. Surgery has improved through OPCAB and carried out according to internationally established techniques. It was performed with the Medtronic Octopus stabilizing devices for coronary stabilization and deep pericardial traction sutures for cardiac displacement and presentation. Conventional immobilization techniques like deep pericardial sutures, esmolol and octopus T-300 were used to provide better access to lateral and posterior target vessels. Heparin 100 mg/kg was administered to keep the activated clotting

time (ACT) between 200 and 400 s. Before anastomosis, the target coronary artery is temporarily occluded proximally and distally by fine bulldog clamps or looped 5/0 Vileene suture. Phenylephedrin was administered intravenously to keep the blood pressure between 70 and 90 mmHg. In these patients, the left internal mammary artery (LIMA) was used as the conduit for all grafts on the LAD while a saphenous vein graft was used for all other coronary vessels.

2.6. Statistical analysis

Numerical variables are presented as mean \pm SD. Discrete variables were summarized by percentages. Student's *t*-test was used to evaluate the significance differences in normal distribution between these two groups, and the Mann-Whitney *U* test was used to analyze the statistical differences between the groups since these were not normally distributed. Furthermore, the categorical variants were evaluated using Pearson's chi-square or Fisher's absolute value chi-square test, and the results were considered to be statistically significant with a *p* value of <0.05 . The long-term survival for each study group was assessed by Kaplan-Meier analysis with log-rank testing. The results are expressed as odds ratios (OR) with associated 95% confidence interval. Cox regression analysis was used to determine variables predictive of survival. All analyses were performed in IBM SPSS Statistics, version 20.

3. Results

3.1. Baseline characteristics and preoperative data

Between March 2011 and February 2012, 474 patients (352 male and 122 female) with a mean age of 58.47 ± 9.6 years underwent OPCAB procedures performed by single surgeon. CE was performed on 69 patients, while the other operations were done without CE. The preoperative demographic and clinical characteristics of these two groups of patients are shown in Table 1. All of the variables were similar in both groups except female gender, renal failure, previous CABG and arrhythmia which were higher in the OPCAB+CE group. But history of smoking was higher in the OPCAB group.

Table 1
Preoperative patients' characteristics.

Variable	CABG + CE (n=69)	CABG (n=405)	p Value
Age (years)	59.13 \pm 10.49	58.43 \pm 9.48	0.569
Sex			
Male	42(60.9%)	309(76.5%)	0.011
Female	27(39.1%)	95(23.5%)	
BMI	27.64 \pm 4.45	26.96 \pm 4	0.354
Diabetes mellitus	22(31.9%)	105(26%)	0.307
Hypertension	38(55.1%)	17(43.8%)	0.090
Hypercholesterolemia	27(39.7%)	129(31.9%)	0.212
Smoking History	21(30.9%)	179(44.2%)	0.046
Renal failure	4(5.8%)	4(1%)	0.018
Family History of CAD	15(21.7%)	120(29.6%)	0.197
Peripheral vascular disease	0	3(0.7%)	1
Congestive heart failure	3(4.3%)	40(9.9%)	0.175
Left ventricular EF	44.31 \pm 10.78	44.38 \pm 11.34	0.963
Previous myocardial infarction	7(10.1%)	40(9.9%)	1
History of arrhythmia	3(4.3%)	3(0.7%)	0.043
Prior PCI	2(2.9%)	9(2.2%)	0.667
Angina	14(20.3%)	115(28.4%)	0.189
Previous CABG	2(2.9%)	0	0.021
Left main coronary diseases	10(14.5%)	85(21.1%)	0.256

BMI = body mass index, EF = ejection fraction, PCI = Percutaneous coronary intervention, CABG = coronary artery bypass graft.

Table 2
Operative Data.

Variable	CABG + CE (n = 69)	CABG (n = 405)	p Value
Number of grafts	3 ± 0.072	2.69 ± 0.034	0.001
Number of vessels Diseased			
I	1(1.4%)	29(7.1%)	
II	9(13%)	93(22.8%)	
III	48(69.6%)	260(63.7%)	0.005
IV	11(15.9%)	26(6.4%)	
Vessels			
LAD	66(95.7%)	403(99%)	0.066
RCA	55(79.7%)	283(69.5%)	0.087
PDA	12(17.4%)	27(6.6%)	0.007
PLV	7(10.1%)	4(1%)	0
Diagonal	2(2.9%)	48(11.8%)	0.031
OM1	53(76.8%)	295(72.5%)	0.557
OM2	7(10.1%)	24(5.9%)	0.189
OM3	1(1.5%)	1(0.2%)	0.266
R.V Branch	0	5(1.2%)	1

RCA = right coronary artery, LAD = Left Anterior Descending Artery, PLV = posterior left ventricular, PDA = posterior descending artery, OM = obtuse marginal, R.V branch = Right ventricular branch

3.2. Operative data

Operative data are presented in Table 2. As a result of more advanced CAD in CE group they have more bypass grafts in comparison to OPCAB group. The most common artery which under gone CE was the right coronary artery (RCA). Forty-four patients (63.8%) underwent RCA endarterectomy, nineteen (13%) patients underwent left anterior descending artery (LAD) endarterectomy, four patients (5.8%) underwent posterior left ventricular (PLV) endarterectomy, eleven patients (15.9%) underwent posterior descending artery (PDA) endarterectomy, two patients (2.9%) underwent diagonal branch endarterectomy, fourteen patients (20.3%) underwent obtuse marginal 1 (OM1) endarterectomy and one (2.2%) patient underwent right ventricular (R.V) branch endarterectomy.

3.3. Postoperative data

Postoperative complications and outcomes are presented in Table 3. In-hospital mortality was 0.7% (3 patients) for the OPCAB as compared with 0% for the OPCAB + CE group ($p = 1$). Of patients who died in the OPCAB group two of them were women and one of them was man. They had three vessels occlusion including LAD, RCA, OM1. It is interesting to note that in this analysis, CE was not associated with increasing in mortality and there is not any significant difference between the two groups.

Table 3
Postoperative Outcomes.

Variable	CABG + CE (n = 69)	CABG (n = 405)	pValue
MI	0	17(4.2%)	0.149
Arrhythmia	6(9%)	23(5.7%)	0.282
Intra-aortic balloon pump insertion	1(1.5%)	1(0.2%)	0.269
Low cardiac out put	7(10.3%)	21(5.2%)	0.159
Respiratory complication	2(2.9%)	5(1.2%)	0.265
Bleeding leading to reoperation	3(4.5%)	30(7.4%)	0.603
Arrest	1(1.5%)	3(0.7%)	0.466
Total blood transfusions (packed red cells)	640.76 ± 886	325.12 ± 448	0.006
ICU stay (days)	51.26 ± 45.8	37.38 ± 17.8	0.015
Hospital mortality	0	3(0.7%)	1

MI = Myocardial infarction, ICU = intensive care unit.

3.4. Survival analysis

After a mean follow up of 37.13 ± 23.82 months in total of 29 deaths, 17 due to cardiac death and 12 due to non-cardiac death. Long term survival rates as estimated by Kaplan-Meier curves in two groups are shown in Fig. 1. Kaplan-Meier survival analysis found overall mean survival of OPCAB patients is 56.28 ± 0.61 compared with 55.54 ± 1.3 for OPCAB + CE patients. Log-rank analysis showed that there was not any significant difference between two groups ($p = 0.66$). 1 and 5-year survival rate in patients undergoing OPCAB + CE was 98.55% and 92.75% respectively. Multivariate Cox regression analysis for the overall study revealed age, gender, BMI, EF, are predictors of mortality. The hazard ratios for these significant factors are given in Table 4.

4. Discussion

The results of the current study demonstrated similar short and long term outcomes between patients undergoing OPCAB and OPCAB + CE. Although many surgeons are still reluctant to use CE in addition to CABG, results of the current study revealed that there is not any significant difference in short and long-term survival between CE+ OPCAB and OPCAB groups (Fig. 1). However, in our study longer ICU stay and higher blood transfusion were seen in OPCAB + CE group. It has been reported that complete revascularization improved early and late outcomes following CABG.^{15,16}

In this study 1 and 5-year survival rate in patients undergoing OPCAB + CE was 98.55% and 92.75% respectively. Previous studies reported a 5-year actuarial survival ranging from 71% to 90%.^{17–19} Shapira and colleagues,²⁰ in 151 patients, reported a five-year survival of 70%. Byrne and colleagues¹³ reported a 74% five-year survival in 190 LAD-CE patients. Sundt and colleagues²¹ reported a 75% five-year survival in 177 CABG/CE patients. The differences in results between various studies can be dedicated by the subtle differences in patient selection, the technique employed, frequency of CE, conduit selection for the endarterectomized target and the mode of reconstruction.

Cox regression analysis show that age, gender, BMI, EF and angina were significant predictors of mortality (Table 4). Livesay et al.²² identified male gender, diabetes mellitus, ventricular dysfunction, higher number of arteries undergoing revascularization per patient. Brenowitz et al.²³ have defined the following risk factors: age >70 years, reoperation, diabetes mellitus, female gender, and severe ventricular dysfunction. They also established a relation between the higher number of these factors and mortality. In this study, we identified following as risk factors for in-hospital mortality: older age at the time of operation, female gender and three vessel diseases following revascularization by OPCAB.

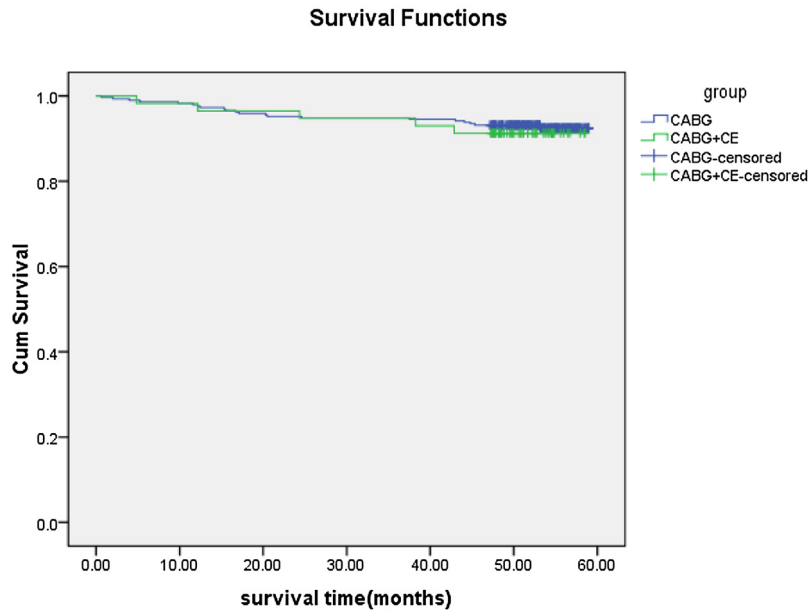


Fig. 1. A: Kaplan-Meier survival curve in CABG and CABG + CE group.

Table 4

Results of multivariate Cox Regression analysis.

Variables	P Value	Hazard Ratio	95% CI
Age	0.003	1.086	1.029–1.145
Gender	0.025	0.164	0.034–0.794
BMI	0.001	1.206	1.07–1.348
EF	0	0.915	0.878–0.954
Angina	0.001	5.815	2.130–15.876

CI = confidence interval, BMI = body mass index, EF = ejection fraction.

In the current study, there was not any significant difference in the hospital mortality rate between the OPCAB+CE and OPCAB groups (0% versus 0.7%). This rate of mortality is acceptable compared to other studies which range from 2.0–6.5%.^{8, 11, 13, 20, 24} In this study, we found that old age at the time of operation, female gender and three vessel diseases were the risk factors for hospital mortality following revascularization by OPCAB. Multiple factors have been reported to predict hospital mortality, such as postoperative MI, age and female gender.^{8,25} Some other studies have found similar results. Shapira et al.²⁰ showed that there was not any significant difference in hospital mortality between CE and non CE patients. Tiruvoipati et al.¹¹ reported postoperative mortality and complications were higher in the CE group. This difference reported on outcomes, may be due to associated comorbidities, and not CE.

In this study, CE was performed on 14.6% of the patients in one year. In the most studies, this percentage has been less than or equal to 10%.^{4,13,20,21,26} In this study, all of the operations in the both groups were performed off-pump. It has been reported that the off-pump technique has a good postoperative outcome in endarterectomized patients.^{27,28} However, the off-pump technique is mostly used in cases with few numbers of grafts,^{4,27–30} other studies have been reported OPCAB for multivessel myocardial revascularization reduced perioperative morbidity.^{8,14} In this study, patients with three or four vessel disease had surgery with acceptable outcomes.

In this study, the rate of postoperative MI was not significant in both groups. Vohra et al.²⁸ reported 4.3% for the postoperative MI rate. Nurozler et al.³¹ reported a perioperative MI rate of 6.2%. In

both of these studies, off-pump technique was used for CE and the majority had single vessel CE to RCA. In this study majority of patients had RCA (63.2%), OM1 (20.6%) and LAD (13.2%) endarterectomy.

The limitation of the current study were the retrospective design, small number of patients in each group, Lack of postoperative angiography to assessing graft patency in endarterectomized, non-endarterectomized coronary arteries, and echocardiography results for assessing postoperative EF. Strengths of the current study are exclusion patients with aortoplasty and other cardiac disease, using off pump technique in all patients and performing CE in average 3 vessels.

Short and long-term survival, hospital mortality and postoperative MI did not differ in both groups. Only blood transfusion and duration of ICU stay was significantly higher in the OPCAB +CE patients but the need for postoperative balloon pump was similar in both groups. All these evidence show that CE is better to be performed than incomplete revascularization. With a careful patient selection, improved anesthesia, myocardial protection, advanced surgical technique and better postoperative management we could get good results.

5. Conclusion

The current study demonstrates that results of CE are acceptable with respect to short and long term survival. CABG and adjunctive CE are offered valuable surgical options for patients that complete revascularization could not be obtained. With careful selection of patients, well-judged and a well-executed surgical technique, followed by close postoperative care, excellent results can be obtained.

Conflicts of interest

The authors have none to declare.

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