Cardiovascular Revascularization Medicine 18 (2017) 332–337

Contents lists available at ScienceDirect

Cardiovascular Revascularization Medicine

Outcomes after a left anterior descending artery endarterectomy in advanced coronary artery disease

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ARTICLE INFO

Article history:
Received 30 November 2016
Received in revised form 5 February 2017
Accepted 15 February 2017

Keywords:
Coronary endarterectomy
Coronary artery bypass grafting
Coronary flow reserve

ABSTRACT

Background: Coronary endarterectomy albeit infrequently utilized remains a pivotal treatment modality for advanced atherosclerotic heart disease. Benefits of coronary endarterectomy are explored in terms of better mid-term survival, freedom of major adverse cardiac and cerebrovascular events and improved left ventricular ejection fraction.
Methods: 50 patients with coronary artery disease including extensive diffuse LAD disease underwent a left anterior descending artery endarterectomy with coronary by-pass grafting and left internal mammary artery as conduit between 2006 and 2014. Prospective evaluation was performed on an outpatient basis with physical examination, echo recordings of ejection fraction and LAD flow reserve for 24 up to 60 months.
Results: Study group was constituted by a male to female ratio 4:1 and mean age 62.4 years old. Pre-operative characteristics included patients with age < 60 years old and gensini score > 60 in 42.1% while patients with age > 60 years old had gensini score (21–60) in 63.4%. Furthermore, males were affected more severely by atherosclerosis than females. Postoperative anterior wall contractility of left ventricle was improved (56% pre-op vs. 66% post-op) and hypokinesis reduced (34% pre-op vs. 24% post-op). No deaths were recorded for a mean follow-up of 48 months. Also, MACCE were recorded in 8% patients. Post-operative LAD flow reserve was normal in 66% and reduced in 33% of cases. Finally, gensini score preoperatively affects mid-term flow reserve postoperatively ($p < 0.05$).
Conclusion: Coronary endarterectomy presents a viable modality that preserves myocardial function and restores LAD flow in patients with diffuse atherosclerotic LAD. Also postoperative adverse effects were minimal while mid-term flow reserve was affected by preoperative factors.

1. Introduction

Coronary endarterectomy (CE) with coronary artery by-pass grafting (CABG) presents an adjunct treatment option for severe diffuse atherosclerotic otherwise non-graftable heart disease. Early studies on CE showed increased perioperative morbidity and mortality [1] which discouraged its application. However later meta analyses observed similar results up until 2000 while more recent articles underscore that perioperative and short-term adverse effects of CE-CABG are almost identical to those of simple GABG [2,3].

Certain factors contributed to this improvement including: a) better understanding of coronary artery disease (CAD) as side branches of left anterior descending artery (LAD) and their perfusion is essential to maintain left ventricular ejection fraction (LVEF), b) strictly defined angiographic and operative criteria for CE, c) greater number of patients with severely diffuse and multiple CAD seeking definitive therapy and d) plateau on learning curve of surgeons for a technically demanding operation.

Our study records mid-term outcome of patients undergoing CE in LAD with CABG prospectively in order to assess LAD patency, LVEF and major adverse cardiac and cerebrovascular events (MACCE) as well as factors that predict adverse outcome.

2. Materials and methods

2.1. Study population

Our study includes 50 consecutive patients that were operated in the context of multiple CAD from 2006 till 2014. All patients presented with severe and diffuse non-graftable LAD coronary artery atherosclerotic disease. This study was approved by the hospital's institutional ethics committee (555/23–10-2015).

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http://dx.doi.org/10.1016/j.carrev.2017.02.015
1553-8389/

2.2. Indication of the LAD endarterectomy

Closed LAD endarterectomy during CABG was chosen based on: a) pre-op coronary angiogram showing an LAD diameter less than 1 mm with multiple severe stenosis (>70%) or b) no identifiable LAD lumen and inability of 1 mm probe to advance distal to the LAD arteriotomy intra-operatively.

2.3. Follow-up methods

Mid-term follow up included: 1) periodical outpatient's clinical visits, 2) evaluation for possible MACCE and 3) transthoracic echocardiography (TTE) evaluation of LVEF as well as Doppler guided adenosine stress test to measure LAD fraction flow reserve as a surrogate for LAD patency [3,4]. Subsequent statistical analysis was conducted to estimate mid-term results to the aforementioned group of patients and probable predicting factors that affect mid-term prognosis.

2.4. Statistical analysis

SPSS (SPSS Inc., Chicago, IL, USA) version 20.0 software was used for all the analyses. Methods included descriptive statistical results for all variables such as mean value, standard deviation, minimum and maximum values. Also chi-square test, t-test, one way ANOVA test and multiple regressions were implemented to elucidate possible correlations among certain variables. $p < 0.05$ was set as a cutting point of statistical significance. Finally, Kaplan–Meier survival diagrams were utilized to depict aggravated complications for the time period of our study.

3. Results

3.1. Pre-operative and peri-operative data

3.1.1. Study population analysis

A total number of 50 patients were enrolled in our study with a male to female ratio of 4:1. Preoperative characteristics were mean age 62.4 ± 6.81 years, Euroscore II (ES II) =1.34 ± 0.86% and LVEF = 49.68 ± 9.02%. In addition, 9 (18%) of them had severe left main (LM) stenosis (Table 1).

3.1.2. Gensini score

Gensini score (GS) [2] was calculated for LAD stenosis with a mean value of 48.25 ± 28.54 (Table 1). Further analysis showed that when patients were grouped for LAD lesions in three groups based on GS (0–20, 21–60 and >60) and their age (≤ 60 vs. >60) younger patients were more severely affected (gensini score > 60 in 42.1%) in contrast to older ones with less diffuse disease (GS between 21 to 60 in 63.4%). In addition, severity of atherosclerosis between sexes showed higher scores for male compared to female subjects (men 20–60 in 48.7% and >60 in 30.8% vs. women 20–60 in 62.5% and >60 in 12.5%).

Table 1
Descriptive Statistics Preoperatively for Age, Euroscore, Left Ventricule Ejection Fraction (LVEF), LAD stenosis.

Demographic characteristics	No of patients Total number = 50(%)
Gender	
Male	40(80%)
Female	10 (20%)
Age, range (46–76)	62.4 ± 6.81
Left ventricular ejection fraction, range (30–65) %	49.68 ± 9.02
Left main disease	9 (18%)
Euroscore II (%)	1.3 ± 0.86
LAD stenosis, range (10–160), Gensini score	48,25 ± 28.55

Table 2
Descriptive Statistics Postoperatively for Coronary Flow Velocity (Vmax) Before and After Adenosine Administration, Velocity Time Integral (VTI) Before and After Adenosine Administration, Ratio (Vmax Before/Vmax After) and Left Ventricule Ejection Fraction (LVEF).

Variables	Mean	Median	Std deviation	Range
Vmax before (cm/s)	27.76	25	14.12	10–104
VTI before (cm^2)	10.15	9	5.83	4.90–42.20
Vmax after (cm/s)	67.01	67	24.89	2–183
VTI after (cm^2)	23.75	21	32.64	6–66.60
Ratio	2.58	2.46	12.02	0.12–6.78
LVEF postoperatively	50.08	50	7.28	30–65

3.1.3. Number of grafts during CE-CABG

In all of the study patients extensive closed CE in LAD and end to side left internal mammary artery (LIMA) to LAD was applied. Mean endarterictomised length was 4.82+/−1.1 cm. Half of our participants (54%) underwent GABG × 3, one third (32%) GABG × 2 and the rest of them received from one up to six grafts. No statistical significance was observed in relation to graft distribution between sexes or age groups ($p = 0.556$ and $p = 0.502$ respectively).

3.2. Follow-up data

There were no peri-operative mortality and no deaths during the follow-up period. Post-op follow-up covered a mean period of 48 months and clinical as well as TTE findings were recorded. Periodical clinical examination showed that 91.7% of patients had no recurrence of angina symptoms and no restrictions to daily activities during our study.

3.2.1. Echo guided LAD coronary flow reserve (CFR) and LAD potency

Pharmacological stress test under echo guidance was conducted during a mean follow-up period of 48 months to evaluate LAD flow velocity (Vmax) and measurements were recorded before and after adenosine administration. Descriptive statistics of Vmax and velocity time integral (VTI) of LAD during diastole that measures coronary flow velocity per second, before and after adenosine administration are presented on Table 2. Subsequent coronary flow reserve (CFR) was estimated and a ratio more than 2 was used as a surrogate of normal LAD flow while lower values were indicative of partial LAD obstruction. CFR > 2 was observed in 38 (76%) patients. Our results show that LAD patency is better preserved in females compared to males (CFR > 2 males 76.9% vs. females 100%) ($p = 0.093$) and in younger compared to older patients (94.7% vs. 73.3%) ($p = 0.059$). Consequently, a trend of better LAD potency for younger and female patients exists without reaching statistically significant power in our study. Subsequently statistical analysis with ANOVA test followed in order to elucidate possible relations of ES II, sex, age, LAD stenosis, LAD group stenosis (patients were grouped according to their GS: 0–20, 21–60, >60) and LM disease with Vmax before adenosine administration. The analysis showed that ES II and LAD Gensini group stenosis present statistically significant relation with Vmax before adenosine administration ($p < 0.001$ and $p = 0.008$ respectively). Also, CFR > 2 showed a trend with age, LM disease and sex ($p = 0.387$, $p = 0.207$ and $p = 0.096$ respectively) while no other significant relation was noted as Table 3

Table 3
ANOVA Test Comparing CFR > 2, LAD Flow Velocity (Vmax) Before and After Adenosine Administration a With Age, Sex, Euroscore II, LAD Stenosis, Groups of LAD Stenosis, Left Main Disease and Age Groups.

Factors	Vmax before	Vmax after	CFR > 2
Age	$p = 0.970$	$p = 0.964$	$p = 0.387$
Sex	$p = 0.721$	$p = 0.721$	$p = 0.096$
Euroscore II	*$p < 0.001$	$p = 0.205$	$p = 0.80$
LAD stenosis	$p = 0.323$	$p = 0.158$	$p = 0.386$
LAD group stenosis	*$p = 0.008$	$p = 0.436$	$p = 0.412$
Left main disease	$p = 0.557$	$p = 0.127$	$p = 0.207$
Age group	$p = 0.393$	$p = 0.356$	$p = 0.61$

* Statistical significance for p value <0.05.