SURGICAL OUTCOME OF CORONARY ARTERY BYPASS GRAFTING IN PATIENTS WITH POOR LEFT VENTRICULAR FUNCTION

RUNNING TITLE: CABG IN PATIENTS WITH LF EF<35%

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ABSTRACT

Objective : To evaluate the early and midterm outcome in patients with coronary artery disease (CAD) and severe left ventricular (LV) dysfunction, as defined by ejection fraction (LV EF) less than 35%, after coronary artery bypass grafting (CABG).

Patients and methods : From April 1999 to June 2002, ninety seven patients with CAD and EF < 35% had isolated CABG surgery. Preoperatively, patients were evaluated by history, physical examination, 12-leads ECG, echocardiographic study, and cardiac catheterization. In elective cases, viability studies were performed. All patients had on pump CABG surgery. Patients were managed in the cardiac surgical ICU. After discharge, patients were followed up regularly in the cardiology out-patients clinic.

Results : There were 76 males and 21 females. History of prior myocardial infarction was present in 46%. The main presenting symptoms were angina pectoris, heart failure, cardiogenic shock and pulmonary edema. Preoperatively, 59% of the patients were in New Your Heart Association Classification (NYHA) class III or IV. Coronary angiography revealed left main or triple vessel disease in 82%. More than half of the patients (54%) had moderately to severely dilated LV. The LV EF was: 30 - 35% in 26; 25 – 30% in 54; and 20 – 25% in 17 patients. All patients had LV wall motion abnormalities which were found in more than 2 segments. Intra-aortic balloon pump was used in 36 patients. . The average number of coro-

nary bypass graft was 3 with maximum of 5 and minimum of 2. Left internal mammary artery (LIMA) was used as a graft in all patients. Follow up ranged from 6 to 36 months, mean of 23 months. There were four hospital mortalities, 4 %. Late death occurred in 3 patients, 2 of them were cardiac related. Of the surviving patients, 75% had improvement in their angina class. They moved up to angina class I. Also, there was marked improvement of their congestive heart failure symptoms. 70% of the survivors are in NYHA class I. The LV function, as assessed by echocardiographic EF, had recovered in 74% of the survivors.

Conclusion : CABG in patients with CAD and LV dysfunction has good results. It is a relatively safe procedure with low operative mortality. It improves myocardial function as a result of recruiting the potentially viable myocardium. It dramatically improves the quality of life by reducing symptoms of angina and congestive heart failure. We recommend the routine use of LIMA as an arterial conduit in those patients. We also recommend the liberal use of IABP when indicated and as a prophylaxis, rather than the intensive use of inotropes in the early postoperative period.

INTRODUCTION

It is well known that the combination of severe coronary artery disease (CAD) and advanced left ventricular (LV) dysfunction, defined as ejection fraction (EF) less than 35%, carries a very poor prognosis with medical therapy [1]. The 2-years survival in such group of patients is assessed to be only 31% [2]. In spite of this extremely poor prognosis, traditionally the cardiologists have been reluctant to refer these patients to surgery and also the surgeons have similarly been reluctant to accept them [3]. The recent recognition of the importance of stunned and hibernating myocardium has increased the interest in the possibility of reversal of ventricular dysfunction by restoring coronary perfusion [4]. The acceptance of this concept, coupled with the marked improvement of the techniques of myocardial preservation and the perioperative intensive care management of patients undergoing surgical revascularization of the myocardium, have led increased referral of patients with bad ventricular function to surgical revascularization. Over the past decade, there have been increasing numbers of surgical literature reporting the out-

come of these patients after surgical revascularization [5, 7, 8, 9]. For the purpose of our study, advanced LV dysfunction is defined as ejection fraction< 35% as assessed by echocardiography.

The aim of this study is to evaluate the early and mid-term outcome in 97 patients with CAD and severe LV dysfunction after surgical revascularization by coronary artery bypass grafting (CABG).

PATIENTS AND METHODS

From April 1999 until the end of June 2002, 807 patients underwent isolated CABG. Out of them, 97 had CAD with EF<35%. Excluded from the study are: patients with left ventricular aneurysm, patients with valvular heart disease or patients with ischemic mitral regurgitation. Full history and physical examination was performed in all patients. A preoperative 12-lead ECG was obtained in all patients. The ejection fraction and LV motion were evaluated by echocardiography. Cardiac catheterization and selective coronary angiography was performed to delineate the coronary anatomy. In elective cases dobutamine echocardiography stress test and or Thallium-201 uptake was utilized as a tool to assess the viability of the myocardium. In emergent and urgent cases the patient was admitted to the coronary care unit and stabilized by maximal medical therapy. Nine patients were admitted as emergency either in cardiogenic shock (5 cases) or pulmonary edema (4 cases). Out of these nine, 6 required cardiopulmonary resuscitation and mechanical ventilation 2 to 24 hours before surgery. All patients underwent on-pump CABG. Intra-operative myocardial protection was achieved by cold blood antegrade cardioplegia either alone in combination with retrograde cardioplegia. The ejection fraction and LV motion were evaluated by echocardiography within 24-48 hours before surgery, on discharge, at 3 month and then every 6 month. Data were recorded in the patient's file and retrieved for analysis.

To get the following-up data the patients had been seen in the outpatient clinic or they have been phoned. For statistical analysis the measured values were expressed as range (minimum, maximum) and mean.

RESULTS

Patients' characteristics: The study included 97 patients. Table 1 summarizes their clinical characteristics. A

history of prior myocardial infarction was present in 45 patients (46%). Risk factors for coronary artery disease in our patient group are summarized in table 2. Diabetes was the predominant risk factor found in this study (67% of patients), followed by hyper-lipidemia (56%) and hypertension (54%). The main presenting symptoms were angina pectoris, heart failure, cardiogenic shock and pulmonary edema. Many of our patients had had more than one of these symptoms but we opted to select the major complaint as the main presenting symptom as shown in table 3. Preoperatively, the dyspnea class in 88 patients (excluding 5 with cardiogenic shock and 4 in pulmonary edema) according to the New Your Heart Association Classification (NYHA) was class I in 4; class II in 15; class III in 42; and class IV in 15 patients. So, 59% of the patients were in NYHA class III or IV. Coronary angiography revealed left main or triple vessel disease in 82% of patients. More than half of the patients (54%) had moderately to severely dilated LV. The left ventricular ejection fraction (LV EF) was: 30 - 35% in 26; 25 – 30% in 54; and 20 – 25% in 17 patients. All patients had LV wall motion abnormalities which were found in more than 2 segments of the LV. Table 4 summarizes the echocardiographic evaluation of the LV. Intra-aortic balloon pump (IABP) was inserted in 36 patients (37%). Indications for balloon insertion were cardiogenic shock in 5; severe pulmonary edema in 4; continuing chest pain in 14; difficult weaning from cardiopulmonary bypass in 4 patients. In the remaining 9 patients, IABP was used as a prophylactic measure based on the subjective feeling of the operating team that the patient will benefit from having the balloon inserted in the operating theater. The average number of coronary bypass graft was 3 with maximum of 5 and minimum of 2. Left internal mammary artery (LIMA) was used as a graft in all patients. It was grafted to the left anterior descending coronary artery (LAD) in 92% of the patients, and to a diagonal in the remaining 8%. Radial artery and the right internal mammary artery (RIMA) were also used as arterial conduits in 15 and 4 patients respectively. Reversed greater saphenous vein grafts were used to achieve complete revascularization. The mean aortic cross clamp time was 65 minutes (ranging from 27 to 114 minutes). The mean bypass time was 115 minutes (ranging from 47 to 223 minutes). All patients re-

mained on inotropic support for more than 2 days (range 2 – 6 and a mean of 4 days). The average intensive care unit stay was 6.5 days (range 3 – 25 days). The mean hospital stay was 16 days (range 7 - 45 days). Postoperative follow up ranged from a minimum of 6 months and a maximum of 36 months with a mean 23 months.

Hospital mortality: there were four hospital deaths (4 %). One died in the operating room because of severe low cardiac output, this patient was admitted with cardiogenic shock and arrested in the catheterization laboratory when he developed ventricular fibrillation. That patient was diagnosed to have a left main coronary artery stenosis. Recurrent ventricular arrhythmia leading to unresponsive cardiac arrest was the cause of death in two patients at day 1 and day 4 postoperatively. The fourth patient died because of prolonged low cardiac output with multi-organ failure 17 days after his surgery.

Early postoperative complications: Immediate post-operative complications are listed in table 5. No patient had a new onset postoperative myocardial infarction. Three patients required prolonged ventilation because of stroke in 1 case and lung disease in the other 2. High creatinine level was diagnosed post-operatively in 26 patients, but only 4 of them went into renal failure requiring continuous veno-venous hemodialysis with full recovery of their renal function. Ventricular arrhythmia was the most common postoperative complication. It occurred in 32 patients, all of them responded to medications and electrical defibrillation.

Late postoperative complications: Within 30 days after discharge, 10 patients came back to the cardiac emergency room and were re-admitted because of pericardial effusion in 4 cases, pleural effusion in 3 cases, and new onset fast atrial fibrillation in 3 patients.

Late mortality: There were three late deaths, two of them were cardiac related. The overall mortality was 7%.

LV function and Quality of life: Of the surviving patients, 75% had improvement in their angina class. They moved up to angina class I (figure 1). Also, there was marked improvement of their congestive heart failure symptoms. 70% of the survivors are in NYHA class I (figure 2). The LV function, as assessed by echocardiographic EF, had recovered in 74% of the survivors (figure 3).

Table1: Clinical Characteristics of the 97 study patients

Age	Range from 24 to 90; average 57.2 years
Male/female	76/21
Average number of Grafts/patient (mean)	3
Prior MI	45
In the past 24 hours	06
In the past 1 to 7 days	08
In the past 7 to 21 days	10
More the 21 days	21
IABP (perioperative insertion)	36
Indications for surgery:	
Angina	72
Heart failure	59
Cardiogenic shock	05
Pulmonary edema	04

MI = Myocardial infarction.

IABP = intra-aortic balloon pump.

Table 2: Risk factors for coronary artery disease in 97 study patients

Risk factor	*Number*	*Percentage*
Diabetes	65	67
Controlled/Diet	08	8%
Controlled/OHG	31	32%
Controlled/Insulin	14	14%
Uncontrolled	12	12%
Hyperlipedimia	54	56%
On statin	33	34%
No medications	22	22%
Hypertension	52	54%
Controlled	47	49%
Uncontrolled	05	5%
Smoking	39	40%
Peripheral vascular disease	08	8%
Femoral	04	4%
Cerebral	04	4%
Family history of CAD	08	8%

OHG = Oral hypoglycemic medications.
CAD = Coronary artery disease.

Table 3: The main presenting clinical features in 97 patients

Feature	*Number*	*Percentage*
Angina	58	60%
Class 1	08	14%
Class 2	02	3%
Class 3	39	67%
Class 4	09	16%
Unstable angina	14	14%
Heart failure	16	16%
Cardiogenic shock	05	5%
Pulmonary edema	04	4%

Table 4: Echocardiographic parameters of the left ventricular function

Parameter	*Number of patients*
EF	
30 – 35%	26
25 – 30%	54
20 – 25%	17
LV dimension	
Severe dilatation	12
Moderate dilatation	31
Normal dimension	54
LV motion abnormalities	
Apex	52
Anterolateral wall	92
Lateral wall	70
Septal	61

EF = Ejection fraction.

LV = Left ventricle.

Table 5: Immediate postoperative complications

Complication	*Number*
Low cardiac output	8
Cardiac arrest	4
Ventricular arrhythmias	32
PVCs	32
Ventricular tachycardia	12
Ventricular fibrillation	4
New onset AF	11
Bleeding & tamponade	4
Renal failure	4
Cerebro-vascular accident	1
Seizures	5
Prolonged ventilation	3
Gastrointestinal bleeding	3
Pulmonary infection	4
Sternal wound infection	7

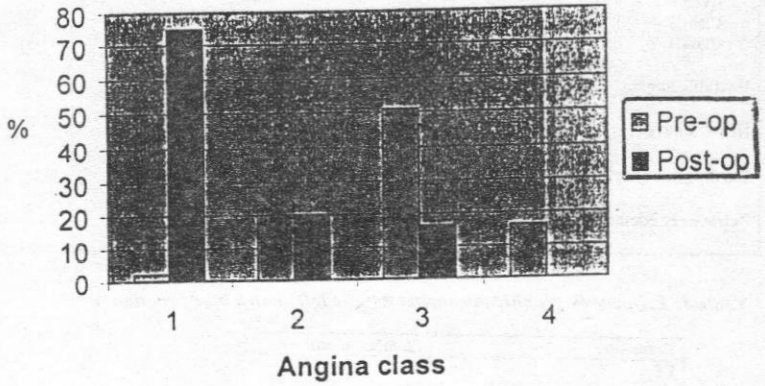

Figure 1 : Comparison between the preoperative and postoperative angina class.

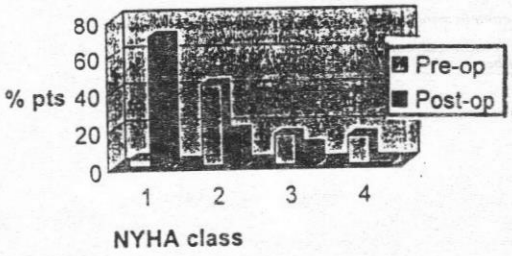

Figure 2 : Comparison of the preoperative and follow up NYHA class.

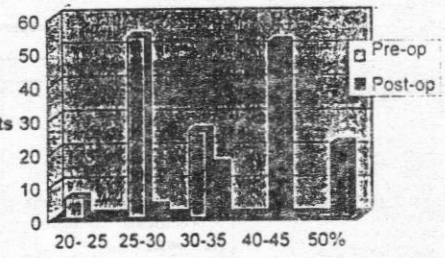

Figure 3 : Comparison of the preoperative and postoperative left ventricular ejection fraction.

DISCUSSION

The term ischemic cardiomyopathy is used to refer to patients with coronary artery disease and poor LV function as evidenced by EF less than 35%.The prognosis of this subset of patients with CAD is very poor when treated medically [1, 5, 6]. The one and two year survival rates for these patients are 54 and 31%, respectively [2]. Typical medical treatment consists of digitalis, diuretics and vasodilators [2, 10]. The recent use of ACE inhibitors seems to improve the 1-year survival rate to 64% for the patients using it compared to 34% survival for control [11]. During the infancy of coronary artery surgery, it was found that impaired LV function increased the perioperative mortality significantly [12]. It therefore became standard practice not to operate on this subset of patients. However, since mid-eighties, rapid advances have been made in surgical techniques, post-operative management, as well as the diagnostic modalities, attention has focused on establishing criteria for myocardial viability in an attempt to identify those patients with viable myocardium that could be recruited and therefore might benefit most by surgical revascularization from those patients with non-viable and scared myocardium [4, 13]. As a natural consequence, several surgical studies have been reported in the recent years showing that surgical revascularization for patients with CAD and poor LV function have resulted in improved myocardial function, significant reduction of symptoms and improvement of the quality of life [5, 6, 8, 13, 14].

Our study has clearly shown that GABG for patients with CAD and EF less than 35% is safe. It is associated with low operative mortality, only 4%. Others have shown a hospital mortality in a range of 3 % to 5% depending on the EF, with a reverse relation between the EF and mortality [1, 3, 13, 15]. This indicates that surgical revascularization is relatively safe in these patients with markedly compromised LV function.

The late mortality ion our patients was 3%. We can not extrapolate a late survival from this study because of the relatively short-term follow up. Others have reported actuarial survival rate of 82%, 79% and 73%, and 1, 2 and 5 years, respectively [3]. It is important to mention that our study have shown that once the patient passed the first 2 months after sur-

gery they did not have cardiac related morbidity. None of them either came back with such complication or needed readmission. Also, of note, 75% of patients who was presented with angina preoperatively had improvement in their angina. They moved up to angina class I (figure1). Also, there was marked improvement of their congestive heart failure symptoms. 70% of the survivors are in class I NYHA (figure 2). The LV function, as assessed by echocardiographic EF, had recovered in 74% of the survivors (figure 3). All of this strongly indicates an improvement in the quality of life of our patients. This has been documented by others as well [16]. This is in contradiction to prior recommendations based on earlier studies [3, 17]. Moreover, there is an evidence the lack of global improvement in LV EF is not associated with poorer outcome when compared with those who had improved LV EF. The authors postulated that effective revascularization of ischemic myocardium, even without improvement in ventricular function, protects against future infarction and death [16].

The left internal mammary artery (LIMA) had been used as an arterial conduit (either to LAD in 92% or to a diagonal in 8%) in all of our patients. Even we used the right internal mammary artery in 4 patients. The presence of poor LV function has been known to be a contraindication for the use of LIMA. In a review article by Kron et al in 1989 [18], all reports except one did not refer to the use of LIMA as a vascular conduits in these patients. This was because of the concept that the LIMA, when compared with reversed saphenous vein graft, may develop spasm, with a subsequent decrease in blood supply to the already jeopardized LV, in the early postoperative period especially with the use of inotropes. LIMA spam was not problem at all in any our patient because we have the policy of careful use of ditiazem and nitroglycerin to prevent this problem. Moreover, it is possible that the well know advantage of the much higher long term patency of the LIMA might be beneficial for those patients.

IABP was used in 36 patients. Early in our series we limited its use only to patients with cardiogenic shock, pulmonary edema, or failed to be weaned from cardiopulmonary bypass. However, we recently have adopted the concept of prophylactic use of IABP and we became more lib-

eral with its use whenever we feel that the patient may have problems in immediate postoperative period. The use of IABP augments myocardial performance, in contrast with the use of inotropes, without increasing the workload on the heart or increasing the myocardial oxygen consumption [3, 14]. We did not have serious complications related to the use of IABP as we carefully monitor limb perfusion by assessing the pedal pulse clinically and by Doppler and we remove the balloon as early as possible.

CONCLUSION

This study confirms the good results of CABG in patients with coronary artery disease and LV dysfunction (EF<35%). It is a relatively safe procedure. The operative mortality is low. It improves myocardial function as evidenced by improvement of the ejection fraction in high percentage of patient as a result of recruiting the potentially viable myocardium. It dramatically improves the quality of life by reducing symptoms of angina and congestive heart failure. We recommend the routine use of LIMA as an arterial conduit in those patients as the long term patency of this conduit might be advantageous over the vein graft. We also recommend the use of IABP when indicated and as a prophylaxis, based on subjective evaluation, in patients with very poor LV function. We prefer this prophylactic approach over the intensive use of inotropes in the early postoperative period.

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