MEDIUM - TERM RESULTS OF CORONARY ARTERY BYPASS SURGERY IN PATIENTS WITH SEVERE LEFT VENTRICULAR DYSFUNCTION AND PREOPERATIVELY DOCUMENTED HIBERNATING MYOCARDIUM

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Summary: In patients with multivessel coronary artery disease (CAD), severe left vetricular dysfunction (LVD) and hibernating myocardium (HM) demonstrated on preoperative assessment, coronary artery bypass grafting (CABG) surgery can be performed safely with low operative morbidity and mortality rates. Surgical revascularization of reversibly dysfunctional myocardium improves significantly both patient's clinical status and left ventricular ejection fraction (LVEF). Diagnosis of HM prior to CABG surgery seems to be crucial because it does not leave the patient with multivessel CAD and LVD a candidate only for heart transplantation (HTX). In the presence of HM, more aggressive surgical approach could be recommended to salvage chronically jeopardised but viable myocardium using not only routine CABG procedures in extracorporeal circulation (ECC) but also alternative approach of coronary endarterectomy (EAE) or minimally invasive direct coronary artery bypass grafting (MIDCAB) procedures on beating heart, without any adverse impact on operative mortality.

Key words: *Coronary Artery Disease; Left Ventricular Dysfunction; Hibernating Myocardium; Coronary Artery Bypass Surgery; Coronary Endarterectomy; Minimally Invasive Myocardial Revascularization*

Introduction

The important role of left ventricular (LV) function as a prognostic indicator in patients with CAD has been illustrated in a number of studies (1,3,5,7,15,25,26).

Results of large registries and randomized trials comparing CABG surgery and medical therapy have suggested improved survival in patients with reduced LVEF and multivessel CAD treated with surgery (2,6). However, especially these patients have shown increased surgical risk and lower operative and long - term survival rates than those with normal LVEF (20).

In patients with poor LV function, medical treatment carries a bleak long - term prognosis despite recent advances in farmacological therapy (15,26,32). An estimated 2 - year survival rate in this group of patients is about 30% (34). Although HTX is an attractive option for end - stage ischemic cardiomyopathy, limited donor availability, strict indication criteria and high mortality rate among patients on waiting lists make HTX a very limited option (8,20,21,23).

Over the past decade it has become clear that chronic LVD is not necessarily an irreversible process (1,5). As a result, the concept of myocardial hibernation was introduced by Rahimtoola to describe „a state of significantly impaired LV function at rest due to persistent reduction of coronary blood flow which can be partially or completely restored to normal by improving blood flow or by reducing oxygen demand" (29). In his theory, based on clinical observations, hibernation was described as down-regulation of myocardial function which represented an attempt by myocytes to balance oxygen supply and demand by reducing oxygen consumption, thus preventing myocardial necrosis and ischemic symptoms at rest (30,31). According to various authors, recovery of dysfunctional myocardium in areas of hibernation after revascularization can take several days, weeks or even months to occur following blood flow restoration (16,22,31).

The current clinical challenge is to identify those high - risk patients with multivessel CAD, severe LDV and preoperatively demonstrated HM who are likely to derive greatest functional and prognostic benefit from CABG surgery (11,12,13,28). Moreover, minimizing perioperative and postoperative complications associated with high-risk surgery seems to be another reasonable endpoint to assess myocardial viability in patients with severe LVD prior to CABG (19,31). In patients with preoperatively identified HM, even coronary EAE could be fully justified in order to revascularize reversibly dysfunctional myocardium (14). Furthermore, MIDCAB procedure could be an attractive surgical option, especially when dealing with a very selective group of high - risk patients who suffer from severe is-

chemic but reversible LVD and various comorbidities (e.g. chronic renal dysfunction, lung dysfunction, liver dysfunction, peripheral vascular disease, previous stroke, severe aortic atherosclerotic disease) where standard CABG surgery in extracorporeal circulation (ECC) may be contraindicated (3,24,33).

Patients and methods

Study objective

The objective of the present pilot study was to evaluate early and medium - term results of CABG surgery in patients with multivessel CAD, severe LVD and preoperatively documented HM.

Design

Prospective evaluation (early and medium postoperative outcome) of all patients with severe LVD and preoperatively documented HM who underwent CABG procedure from April 1996 to April 1998 and were referred to the Follow - up Clinic for regular postoperative check - up.

Preoperative data

Seventeen patients (16 men, 1 woman, mean age 61.9± 6.9) with multivessel CAD and preoperative mean LVEF of 28.5±7.1 (range 16 to 38%) were studied and HM as a reversible cause of LVD was demonstrated. Preoperatively all patients had a history of myocardial infarction (100%). Preoperatively the mean NYHA functional class was 3.1±0.4 and the mean left ventricular end - diastolic pressure (LVEDP) was 20±7.9. Signs of congestive heart failure, especially dyspnea were present in 16 patients (94.2%); 11 of our patients (64.7%) suffered from angina pectoris. Nine patients (52.9%) had mild to moderate degree of mitral regurgitation preoperatively classified as ischemic without any valvular morphological changes (Table 1). All patients were preoperatively screened for the presence of HM using a stress echocardiography scan with low - dose dobutamine (5 - 10 µg/kg/min) and „parietoseptography" assessment from coronary angiogram.

Table 1:

Preoperative data	n=17
Age (years)	61.9±6.9
Sex: male	16/17 (94.2%)
female	1/17 (5.8%)
Prior myocardial infarction	17/17 (100%)
NYHA functional class	3.1±0.4
II	1/17 (5.8%)
III	14/17 (82.4%)
IV	2/17 (11.8%)
LVEF (%)	28.5±7.1
LVEDP (mm Hg)	20±7.9
Multivessel CAD	17/17 (100%)
Ischemic mitral regurgitation	9/17 (52.9%)

Operative management:

Fourteen patients (82.4%) underwent isolated CABG using a standard operative technique without any other open heart procedure. Routine ECC was commenced with aortic and two - stage venous cannulas. Myocardial preservation was performed by moderate systemic hypothermia (28 - 30°C); antegrade cold crystalloid, and more recently in 5 patients, blood cardioplegia were administered into ascending aorta after aortic cross - clamping. Topical pericardial cooling with ice was used as an adjunct. Three patients (17.6%) underwent a minimally invasive bypass grafting on beating heart; through median sternotomy approach in one case and through left anterior small thoracotomy /LAST/ approach in two cases, without using heart - lung machine The number of distal anastomoses carried out per patient was 2.7 (range 1 - 4) always aiming at complete revascularization. The left IMA (LIMA) was used in 11 patients (64.7%). Coronary EAE was performed in 2 patiens (11.8%).

Follow - up

All patients were followed up (100% follow - up) for 2.9 to 24.5 months (the mean follow - up 17.1 months). The follow - up included assessment of survival, clinical status (NYHA classification) using a routine clinical check - up and LVEF from a standard transthoracic echocardiography scan.

Results

Postoperative data

In 16 patients (94.2%) we used dopamine infusion for perioperative and early postoperative inotropic support. Intraaortic baloon pumping (IABP) was used peri - and postoperatively only in one patient (5.8%).

Mortality

None patient died within 30 days postoperatively. One patient could be weaned from ECC only with inotropic and IABP support; on the 6th postoperative day he developed respiratory distress syndrome (ARDS) and needed longer ventilatory support. Except of that there were no other significant non-lethal complications present during early postoperative period.

Late mortality

During the follow - up period ranged from 2.9 to 24.5 (the mean 17.1 months) there was no death in the studied group. Thus, survival rate was 100%. The mean LVEF increased postoperatively from 28.5±7.1 to 44.8±7.8 (p<0.0001). The mean NYHA functional class improved from 3.1±0.4 preoperatively to 1.6±0.7 postoperatively (p<0.0001). None patient needed any interventional procedure, redo CABG nor HTX during follow - up period. The summarised postoperative data are tabulated in Table 2.

Table 2:

Postoperative data	n=17
Dopamin postoperatively	16/17 (94.2%)
IABP	1/17 (5.8%)
Number of distal anastomoses	2.7 (1 - 4)
LIMA	11/17 (64.7%)
EAE	2/17 (11.8%)
MIDCAB	3/17 (17.6%)
Mortality: 1. Early (30 - day mortality) 2. Late	 0/17 (0%) 0/17 (0%)
Mean Follow - up (months)	17.1 (2.9 - 24.5)
LVEF (%)	**44.8±7.8** ($p < 0.0001$)
NYHA functional class I II III	**1.6±0.7** ($p < 0.0001$) 9/17 (52.9%) 6/17 (35.3%) 2/17 (11.8%)
PTCA or redo CABG	0/17 (0%)
HTX	0/17 (0%)

Discussion

Advanced CAD and ischemic cardiomyopathy are criteria of a severe illness (18). However, in selected cases surgical revascularization has proved beneficial in terms of survival, reduction of morbidity and lowering the frequency of angina in numerous studies over past two decades (17,19,20,27,28). Despite increased surgical risk and higher long - term mortality rates than patients with normal LVEF, patients with LVD and multivessel CAD undergoing CABG surgery have shown improved outcome compared with those treated medically (1,28).

Severe LVD can be result either of myocardial necrosis or myocardial hibernation (16,31). The noninvasive assessment of myocardial viability has been shown clinically useful for demonstrating residual myocardial viability and predicting improvement in global and regional LVEF after CABG surgery in patients with significant LVD (2,3,4,6). The currently most frequently used techniques include scintigraphic imaging with either positron emission tomography (PET) or single photon emission computed tomography (SPECT) and stress echocardiography during stepwise infusion of dobutamine (DSE) (6,9,10,33). The results obtained from these techniques are more - less comparable in preoperative identification of viable myocardium (2,3,4).

Only if viability can be demonstrated, are revascularization procedures fully justified (2,3). Few recent studies have shown that the greater the number of viable myocardial segments detected by any diagnostic tool the greater the probability of improvement in LVEF following CABG and thus, better short- and long-term outcome after CABG than in similar patients with lesser amounts of viability (13,28). On the other hand, patients with a depressed LV function and extensive myocardial viability treated medically have a high cardiac event rate. Similarly, patients with poor viability who still undergo CABG procedure have a high rate of early and late cardiac deaths or need for HTX compared with patients with greater viability (13,28).

Furthermore, some studies have also clearly shown that patients with ischemic cardiomyopathy who have extensive zones of viable (hibernating) myocardium have a significantly better outcome following CABG surgery than do those treated medically, as reflected by enhanced survival, improvement in symptoms of heart failure and increased exercise capacity (12,17,18,28). Another conclusion that can be drawn is that patients with predominantly nonviable myocardium have a rather poorer long-term outcome following CABG (28). Rejecting such patients from surgery should result in a reduction in costs as a result of avoiding surgical interventions that are unlikely to be of major short-term or long-term benefit. Thus, these patients are the ultimate candidates only for HTX (8). Future prospective studies might help in providing more specific data to prove these assumptions and to assist in clinical decision making (28).

Medical management of HM does not result in improvement in symptoms and LV performance deteriorates over time without revascularization (13).

Study limitations

The present pilot study evaluated early and medium - term postoperative results in symptom profile and LVEF changes in a highly selected population of patients with multivessel CAD, severe LVD and preoperatively demonstrated HM who underwent CABG surgery. The selection of therapy was made not on randomised basis, but on clinical basis alone. In addition, this study specifically excluded patients who underwent combined open heart procedures.

Limitations of the present pilot study are based on a small number of patients and also on a very selected population. It does not compare outcome of the patients included in the study with a similar cohort of patients who were not treated with surgery. Therefore, it could not provide guidance for selection of such high - risk patients either for CABG surgery or medical therapy. Another limitation of the study is that we did not use any of scintigraphic imaging scans in addition to DSE to increase the probability of tissue viability detection.

Conclusions

CABG surgery may be offered even to patients with severely depressed LV function if the presence of HM as a reversible cause of LVD has been identified by any of diagnostic tools. Viability assessment in patients with multivessel CAD and severe LVD prior to CABG surgery seems to be crucial because it does not leave the patient with multivessel CAD and LVD a candidate only for HTX. In the presence of HM, more agressive surgical approach

could be recommended to salvage chronically jeopardised but viable myocardium using not only routine revascularization surgical techniques in ECC but also alternative approach of coronary EAE or MIDCAB grafting on beating heart, without any adverse impact on operative mortality.

We are encouraged by our premilinary results to continue in the direction of preoperative viability assessment in this highly selected group of patients. If HM is preoperatively identified, routine surgical revascularization could be employed and the results in terms of low mortality as well as excellent outcome may be expected. On the other hand, in patients with reversible ischemic LVD who have significant comorbidities that significantly increase the risk of a standard surgical intervention, MIDCAB procedure without using heart - lung machine can be considered as an alternative treatment to revascularize viable myocardium.

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