Biological and clinical outcomes in the elderly with left ventricular dysfunction

Are there differences between on-pump and off-pump coronary artery bypass grafting?

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Biological anc clinical outcomes in the elderly with left ventricular dysfunction:Are there differences on-pump and off-pump coronary artery bypass

AIM: *To compair biological and clinical outcomes after off-pump coronary artery bypass grafting (OPCABG) and conventional on-pump coronary artery bypass grafting (CCABG) in the elderly with left ventricular (LV) dysfunction.*
MATERIAL OF STUDY: *We retrospectively reviewed 90 consecutive patients aged more than 75 years with preoperative left ventricular ejection fraction (LVEF) < 50% who underwent isolated coronary artery bypass grafting at our Institution between January 2000 and July 2009. According to operative technique, patients were categorized in to the OPCABG group (39 patients) or in to the CCABG group (51 patients). We compared postoperative CK, CK-MB, troponin T serum levels and major adverse cardiac and cerebrovascular events (MACCE).*
RESULTS:*The overall in-hospital mortality was 2% (2/90) and was similar in both groups (p=0.8336). Mean troponin T levels at 6,24,48 hours after operation were significantly lower in the OPCABG group (p=0.0001; p=0.0021; p=0.0070, respectively). Overall survival was 77.6% at 10 years and no significant difference in MACCE was observed (p=0.3016).*
DISCUSSION:*Our results show a lower incidence of myocardial injury in OPCABG group, but there aren't differences in term of MACCE in both groups. Recent studies have indicated the advantages of OPCABG in the elderly patients, reporting a reduction of postoperative morbidity and organ dysfunction. However these studies not analyzed the impact of LV dysfunction on early and late postoperative outcomes in high-risk patients.*
CONCLUSIONS:*In the elderly with LV dysfunction, the OPCABG technique showed lower incidence of postoperative myocardial injury. However, at the follow-up, this does not reflect any significant differences in incidence of MACCE.*

KEY WORDS: Cardiopulmonary Bypass, Coronary Artery Bypass, Off Pump, Ventricular Dysfunction, Left

Introduction

As the number of elderly increases in the general population, the number of potentially high-risk patients referred for coronary artery bypass grafting (CABG) has also increased [1,2]. The elderly are a challenging group of patients presenting higher incidence of associated comorbid conditions and as consequence of higher estimated mortality, they are often referred later for surgery with advanced disease[2]. Moreover, left ventricular dysfunction has been well recognized as risk factor for operative mortality [3-5].

Recent studies have indicated the advantages of the off-pump coronary artery bypass grafting technique (OPCABG) in the elderly patients, reporting a reduction of blood loss and transfusion requirements, a reduction of postoperative morbidity and organ dysfunction [6-8]. However these studies not analyzed the impact of

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left ventricular dysfunction on early and late postoperative outcomes in these high-risk patients.
The aim of this retrospective analysis is to assess, in the elderly patients with compromised left ventricular function, whether OPCABG improves the biological and clinical postoperative outcomes compared to conventional on-pump coronary artery bypass grafting (CCABG).

Material and Method

INCLUSION CRITERIA

A review of the Cardiac Surgery Database of San Martino University Hospital disclosed 2680 patients who underwent CABG at our Institution from January 2000 to July 2009.
All patients aged 75 years or more, with ejection fraction < 50%, who underwent isolated CABG were considered for this analysis. Patients who underwent CABG as consequence of a iatrogenic trauma were excluded. Following these criteria, 90 patients were included in this study.

Patient Characteristics

The baseline clinical characteristics of the study patients are detailed in the Table I. Fifty-one (56.7%) patients were operated with cardiopulmonary bypass (CCABG group), and 39 (43.3%) patients (OPCABG group) were operated without cardiopulmonary bypass.
In the OPCABG group, patients were significantly more likely to have unstable angina (p=0.0051), chronic obstructive pulmonary disease (COPD) (p=0.0031) and hypertension (p=0.0349). The ejection fraction was slightly higher in the OPCABG group (42% OPCABG group and 38% in CCABG group; p=0.0102).
The OPCABG patients received a lower number of grafts (p=0.0009) but a more exclusive arterial revascularization (p=0.0049) (Table II).

END POINTS

The endpoints of this study were early postoperative biological markers of myocardial injury, postoperative complications and incidence of major adverse cardiac and cerebrovascular events (MACCE).
For this purpose we assessed different biomarkers of myocardial injury. Serial samples of blood, approximately 5 mL each, were drawn 6, 24, 48 hours after surgery. Serum Troponin T (TnT) levels were measured with Immunoassay, Roche Modular platform (Roche Diagnostics Corporation, Indianapolis, IN, USA). The upper limit of normal is 0.10 μg/L.
Serum Creatine Kinase (CK) levels were measured with Roche Integra platform (Roche Diagnostic Corporation). The upper limit of normal is 173 U/L. Serum Creatine Kinase MB isoenzyme (CK-MB) levels were measured by using the Immunoassay, Roche Modular platform (Roche Diagnostic Corporation). The upper limit of normal is 5.0 μg/L.

Table I - *Baseline clinical characteristics*

Variables	**Overall n = 90**	**CCABG n = 51**	**OPCABG n = 39**	**P *value***
Age, mean ± SD, y	77 ± 2.07	77.6 ± 2.30	76.7 ± 2.08	0.0470
Sex male, (%)	63 (70)	36 (70)	27 (69)	n.s.
Additive EuroSCORE, mean ± SD	5.7 ± 0.98	5.8 ± 1.03	5.4 ± 0.96	n.s.
Elective (%)	75 (83)	43 (84)	32 (82)	n.s.
Urgent/emergent (%)	15 (16)	8 (16)	7 (18)	n.s.
Hypertension (%)	61 (68)	30 (59)	31 (79)	0.0349
Diabetes mellitus (%)	25 (28)	15 (30)	10 (25)	n.s.
COPD (%)	5 (5.5)	0	5 (13)	0.0031
Chronic renal failure (%)	1 (1)	0	1 (2.5)	n.s.
Neurologic deficit (%)	3 (3)	1 (2)	2 (5)	n.s.
Peripheral vascular disease (%)	14 (15.5)	5 (10)	9 (23)	n.s.
Neoplasia (%)	1 (1)	0	1 (2.5)	n.s.
Preoperative LVEF, mean ± SD	40 ± 2.05	38 ± 2.20	42 ± 2.06	0.0102
LVEF 30-50% (%)	84 (93)	47 (92)	37 (95)	n.s.
LVEF < 30% (%)	6 (7)	4 (8)	2 (5)	n.s.
Preoperative persistent atrial fibrillation (%)	1 (1.1)	1 (2)	0	n.s.
Unstable angina (%)	11 (12)	2 (4)	9 (23)	0.0051
Congestive heart failure (%)	2 (2)	1 (2)	1 (2.5)	n.s.

CCABG, conventional on-pump coronary artery bypass grafting; OPCABG, off-pump coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; LVEF, left ventricular ejection fraction; SD, standard deviation.
Elective, Urgent, Emergent, Renal failure, Neurologic deficit, Peripheral vascular disease, Unstable angina and Congestive heart failure were defined according the EUROscore criteria

Table II - *Operative data*

Variables	Overall n = 90	CCABG n = 51	OPCABG n = 39	P *value*
Cross-clamp time, mean ± SD, (min)		53.1 ± 24.01	0	
CPB time, mean ± SD, (min)		92.3 ± 36.05	0	
Grafts, mean ± SD	2.8 ± 0.20	3.1 ± 0.18	2.5 ± 0.22	0.0009
LIMA use, (%)	82 (91)	49 (96)	33 (85)	n.s.
BIMA use, (%)	1 (1)	0	1 (2.5)	n.s.
RA use (%)	41 (45.5)	20 (39)	21 (54)	n.s.
Exclusive arterial revascularization (%)	16 (18)	2 (4)	14 (36)	0.0049
SVG use (%)	83 (92)	48 (94)	35 (90)	

CCABG, conventional on-pump coronary artery bypass grafting; OPCABG, off-pump coronary artery bypass grafting; CPB, cardiopulmonary bypass; LIMA, left internal mammary artery; BIMA, bilateral internal mammary artery; RA, radial artery; SVG, saphenous vein graft; SD, standard deviation.

MACCE analyzed included cardiac death, postoperative myocardial injury or myocardial infarction, repeated coronary revascularization by percutaneous intervention or surgery, and cerebrovascular events (stroke or transient ischaemic attack). Any death was considered cardiac unless proven otherwise. Postoperative myocardial injury was defined as the presence of ECG abnormalities associated to a high postoperative troponin level, postoperative inotropic support and new postoperative echocardiographic kinetic alteration.
ECG abnormalities were defined as new ST elevation or new left bundle branch block not documented to be resolved within 20 minutes or any new pathological Q-wave [9].

Follow-Up

The follow-up was obtained from direct telephone calls with the surviving patients or with families and referring physicians. Questions were addressed in regard to their actual functional status and incidence of MACCE. Follow-up was 98% complete (88 of 90 patients). Mean follow-up time of 4.9 years.

Operative Procedures

Operations were performed by a group of 4 senior surgeons with longstanding experience in both off-pump and on-pump CABG surgery. The decision to perform CABG with or without cardiopulmonary bypass was individually based on the preoperative assessment of the surgeon, including patients' preoperative hemodynamic, concomitant disease, and extent of acute coronary syndrome. Patients were premedicated with promethazine. All patients received a standardized totally intravenous anesthesia with propofol, and remifentanyl. Ventilation was performed with oxygen in air. Perioperative antibiotic prophylaxis was provided with 1 g of injection cefazolin administered intravenously.
In all patients, surgical access was performed via median sternotomy.

CCABG group. All patients in this group underwent revascularization during normothermic CPB by using aortoatrial cannulation. Heparin was administered at a dose of 3 mg/kg to achieve a target activated clotting time (ACT) of 480 seconds or greater before commencement of CPB. Myocardial protection was achieved by means of anterograde intermittent administration of normothermic blood cardioplegia through the aortic root. Hematocrit was kept above 20% with packed red blood cells if necessary. Perfusion pressure during CPB was kept above 50 mmHg with norepinephrine if necessary. Mean arterial pressure after CPB was kept above 60 mmHg with volume and vasoactive drugs as appropriate. ICU treatment was performed according to institutional standards.
OPCABG group. In the OPCABG group heparin (1.5 mg/kg) was administered before the start of the first anastomosis or before the division of the left internal mammary artery. The target ACT in this group was 250 to 300 seconds. Colloids were administered, and position changes and gravity support (Trendelenburg and right and left rotation) were used to stabilize patients' hemodynamics and to maintain a controlled systolic arterial pressure to optimize coronary perfusion. A myocardial coronary artery stabilizer system and intracoronary shunts were used in all cases.
The distal anastomoses were performed first. The left anterior descending coronary artery (LAD) was revascularized first. Proximal anastomoses were performed on the partially clamped ascending aorta. ICU treatment was performed according to institutional standards.

STATISTICAL ANALYSIS

The design of the study was retrospective and analysis was performed with the JMP 7 statistical analysis software (SAS Institute, Cary, NC). Continuous variable are presented as mean ± standard deviation, and categorical variables are expressed as frequencies.
Comparison between variables was performed by means

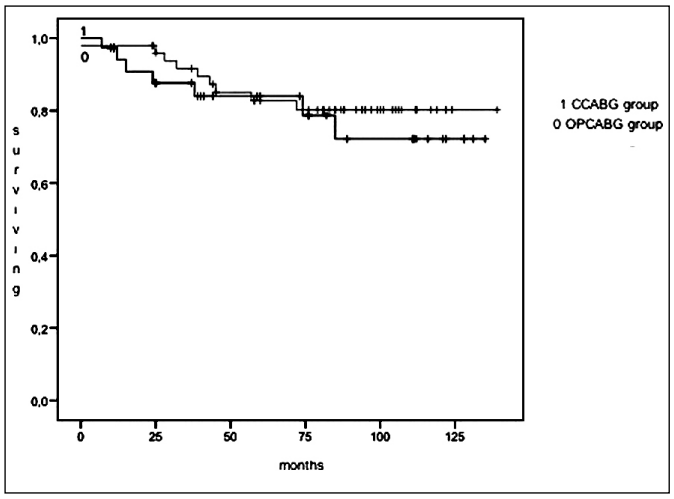

Fig. 1: Survival after the operation according to the surgical technique.

of the χ^2 test or Fisher exact test where appropriate.
A search of risk factors for late death was performed. A univariate analysis was done first. The curves were stratified on the basis of binary variable and compared with the Log-Rank test. Variables with a p<0.2 underwent multivariable model for Cox regression analysis to determine the independent predictors of late death. A *p* value less than 0.05 was considered to be statistically significant. Survival and event-free estimates were determined by the Kaplan-Meier method and are expressed as the proportion ± standard error.

Results

Early and Late Mortality

Overall in-hospital mortality was 2.5% in OPCABG group and 2% in CCABG group (one patient on each group) (p=0.8336). Patient operated under cardiopulmonary bypass was 77 years old presenting a severe left ventricular dysfunction (LVEF 25%) and an additive EuroSCORE of 8. He underwent a complete revascularization during a short cross clamping and CBP time (26 min and 40 min, respectively). Weaning from the cardiopulmonary bypass was difficult and required a prolonged postoperative inotropic support. The postoperative course was complicated by a multiorgan failure and he died at postoperative day 10.
Patient operated without CPB was 80 years old presenting a severe COPD and an additive EuroSCORE of 13. The postoperative course was complicated by a severe respiratory failure requiring prolonged postoperative intubation. He died at postoperative day 7.
There were 14 late deaths. Neoplasia was the most common cause of death (4 pulmonary neoplasia, 2 prostatic neoplasia and 1 renal neoplasia). Two patients died as consequence of stroke. In 5 patients the cause of death was cardiac.
One-, 5- and 10-year survival was 97.4%, 84% and 72.2% in OPCABG group and 98%, 82.8% and 80% in CCABG group (p=0.0764) (Fig. 1).

Biomarkers of Myocardial Injury

Postoperative serum TnT, CK and CK-MB levels are listed in Table III. Postoperative CK and CK-MB levels were similar between the groups but postoperative TnT serum levels were significantly lower after OPCABG surgery.

Early Postoperative Complications

A total of 41 patients (45.5%) presented one or more postoperative complications. ECG abnormalities occurred in a total of 26 patients (28.8%) (5 of 39 patients in the OPCABG group and 21 of 51 patients in the CCABG group; p=0.0024) and was successfully treated with nitrates administration until electrocardiography normalization.

Table III - *Postoperative CK, CK-MB and TnT serum levels according to the surgical technique*

Variables	Overall n = 90	CCABG n = 51	OPCABG n = 39	P *value*
CK, mean ± SD, (U/L)				
6h postop.	403.7±279.04	483.4±277.16	299.4±281.50	0.0026
24h	760.1±630.81	716.8±88.33	816.7±101.01	n.s.
48h	598.8±490.99	526.2±68.75	693.7±78.62	n.s.
CK-MB, mean ± SD, (U/L)				
6h postop.	16.2±12.64	21.7±1.77	8.9±2.02	0.0001
24h	17.8±20.95	20.3±2.93	14.4±3.35	n.s.
48h	9.2±9.65	9.6±1.35	8.8±1.54	n.s.
TnT, mean ± SD, (μg/L)				
6h postop.	3.6±4.08	5.6±0.57	1±0.65	0.0001
24h	4.3±5.03	5.8±0.70	2.4±0.80	0.0021
48h	2.8±3.80	3.7±0.53	1.5±0.60	0.0077

CCABG, conventional coronary artery bypass grafting; OPCABG, off-pump coronary artery bypass grafting; CK, creatine kinase; CK-MB, creatine kinase MB; TnT, troponine T; SD, standard deviation; n.s., not significant.

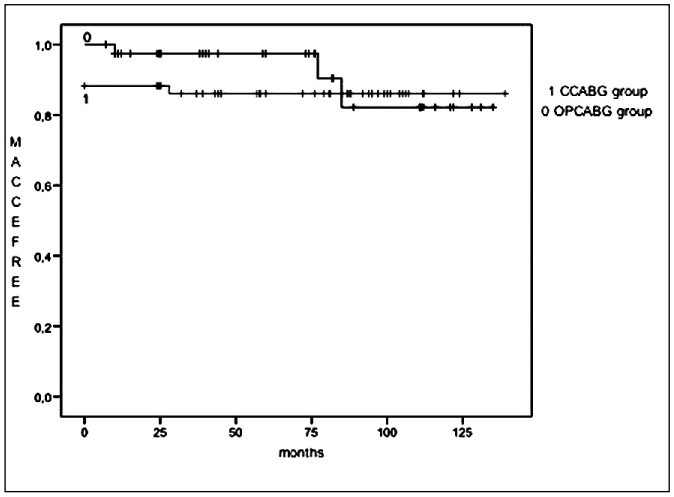

Fig. 2: MACCE–free survival after the operation according to the surgical technique.

Patients with an ECG abnormalities were more likely to have a higher troponin T peak level (p=0.0245), male sex (p=0.0444), diabetes mellitus (p=0.0155), on-pump CABG (p=0.0024), mammary artery graft (p=0.0163), blood loss (p=0.0096) and blood transfusion (p=0.0446).
A myocardial injury was observed in 6 patients (six of six patients in the CCABG group; p=0.0075).
One patient had a transient ischaemic attack at postoperative day 3. He received 5 grafts with CPB.
MACCE rate at 30 days was 13.7% (seven of 51 patients) in CCABG group and 0% in OPCABG group (p=0.0038).
Despite only one patient presented preoperative persistent atrial fibrillation, postoperative atrial fibrillation was common (24%; 22 of 90 patients) and was similar in the groups (p=0.8175). Postoperative atrial fibrillation was successfull treated with Amiodarone or, in those with hemodynamic instability, with synchronized electrical cardioversion so that at discharge, there were 88 in sinus rhythm.
No patient presented postoperative acute renal failure.
Despite mean postoperative blood loss was similar (p=0.1462) in two groups, patients in the OPCABG group required less blood transfusion (p=0.0180) (Table IV) and one patient in the CCABG group was reoperated for excessive bleeding 6 hours after operation. This patient was treated with preoperative antiplatelet drugs. In ICU stay protamine was administered. The sources of bleeding were sternum and mediastinal soft tissue.

Late Clinical Outcomes

At follow up, 2 patients presented recurrent angina, one of the OPCABG group and one of the CCABG group (p=0.8336), with complete regression of the syntomatology after oral nitrates administration. Both patients had a preoperative moderate left ventricular dysfunction (LVEF=40%) and underwent a complete revascularization. Both patients developed postoperative congestive heart failure, treated with inotropic supports. No patient required hospitalization for percutaneous transluminal angioplasty or reoperation for CABG.
Two patients had postoperative ischaemic stroke, one in each group (p=0.8336). Both patients had atherosclerotic peripheral vascular disease and both patients received 3 grafts. One patient had stroke 2 years and one patient 3 years after operation. Both patients had postoperative atrial fibrillation treated with synchronized electrical cardioversion and with Amiodarone. At dimission one of this patient was in sinus rhythm and one in atrial fibrillation. This patient had warfarin in therapy.
At 10 years, MACCE-free survival rates were 82.2% and 86% in OPCABG group and CCABG group, respectively (p=0.3016) (Fig. 2).

Risk Factors for Late Death

At multivariate Cox proportional hazard analysis, COPD (p=0.0201) and ECG abnormalities (p=0.0469) after CABG emerged as the only independent predictors for late death.

Table IV - *Postoperative patient findings and early clinical outcomes.*

Variables	Overall n = 90	CCABG n = 51	OPCABG n = 39	P *value*
New postoperative atrial fibrillation (%)	22 (24)	12 (23.5)	10 (25.5)	n.s.
Peak of postoperative troponin, mean ± SD, (μg/L)	3.65 ± 0.64	5.07 ± 0.60	1.67 ± 0.69	0.0033
ECG abnormalities (%)	26 (29)	21 (41)	5 (13)	0.0024
Postoperative inotropic support (%)	59 (64)	38 (74.5)	21 (54)	n.s.
Blood loss, mean ± SD, (ml)	600 ± 0.37	645 ± 0.45	541 ± 0.34	n.s.
Transfused patients (%)	55 (61)	37 (72.5)	18 (46)	0.0180
ICU stay, mean ± SD (days)	1.63 ± 0.84	1.74 ± 0.95	1.48 ± 0.75	n.s.
In-hospital mortality (%)	2 (2%)	1 (2%)	1 (2.5%)	n.s.

CCABG, conventional on-pump coronary artery bypass grafting; OPCABG, off-pump coronary artery bypass grafting; ECG, electrocardiogramm; ICU, intensive care unit; SD, standard deviation.

Discussion and Comments

Facing to the ageing population, the numbers of elderly patients referred to the surgery is increasing. These patients have diminished functional reserves, left ventricular dysfunction, and are more likely to have preoperative co-morbid conditions. Management of elderly patients with impaired left ventricular function caused by coronary artery disease remains a challenge. The options of treatment are limited and are associated with variable outcomes. Surgical intervention by CABG has been regarded as a high risk procedure, and is associated with high rate of morbidity and mortality [3-5]. However, recent studies have reported encouraging early and mid-term results, and satisfactory long-term survival in selected patients [10,11]. As a result of the increased popularity and success during the past decade, OPCABG seems to be a good surgical option. Good surgical results were obtained from different studies [12,13].

In our experience, despite similar preoperative characteristics and probably due to the small number of patients enrolled in each group, early and late clinical outcomes was similar in patients treated with and without cardiopulmonary bypass. The OPCABG was associated with a significant lower peak of troponin serum levels and a lower incidence of ECG abnormalities without affecting the early mortality or ICU stay. Troponin serum levels are well-recognized markers of myocardial injury and its superiority for quantifying myocardial necrosis and predicting impending complications following cardiac surgery is now well documented. Koh and coll. [14] had shown its great specificity, sensitivity and negative predictive value in the diagnosis of postoperative myocardial infarction and allows identification of those underestimated by current criteria (ECG, CK-MB, myocardial scan) and this finding is confirmed by several studies [15-24].

According to literature [25-28], our data suggests that a measurable cardiac damage exists during surgical revascularization, and this damage is greater with on-pump revascularization, despite advances in myocardial preservation and cardiopulmonary bypass conduction a better perioperative myocardial protection during CCABG. Ascione and coll. [25] and Kilger and coll. [26] found that cardiac troponin I release was constantly lower in their OPCABG group at multiple postoperative time points. Krejca and coll. [27] found 12-fold higher TnT levels 24 hours postoperatively in their CCABG group. If cardiac damage is well demonstrated, our study suggests that its impact on mortality and postoperative complications is irrelevant. Probably, serum troponins (both I and T) are too sensitive in detecting postoperative myocardial damage and we agree to Chowdhury and coll. [28] when they define this cardiac damage as subclinical and transient.

Indeed, at the Cox analysis, the postoperative troponin serum levels were not found as risk factor for late death and late survival was not different in patients with higher early postoperative TnT serum levels. This may probably related to the small sample of patients enrolled in each group but it needs to be investigated. On the contrary, in our study, early postoperative ECG abnormalities were more sensitive to predict poor late outcomes. At univariate analysis, male sex (p=0.0444), diabetes mellitus (p=0.0155), on-pump CABG (p=0.0024), blood loss (p=0.0096) and transfused patients after CABG (p=0.0446) emerged as the independent predictors for ECG abnormalities after surgical revascularization (Table IV).

The high sensitive of serum TnT levels may explain its incapacity to distinguish clinical and subclinical myocardial damage and its role need to be reconsidered.

In our study, contrary to previous reports [8,29-35], the surgical strategy didn't affect the late clinical outcomes in the elderly with left ventricular dysfunction. At follow up, MACCE, including cardiac death, postoperative myocardial injury or myocardial infarction, any revascularization and cerebrovascular events (stroke or transient ischaemic attack), was similar.

However some limitations exist in our study. The present series is a retrospective analysis. The sample is small, patients were not randomized, but were enrolled in each group according to the intraoperative surgeon decision.

Variables	Definitions
Preoperative congestive heart failure	chronic or episodic peripheral oedema, pleural effusion, or hepatomegaly (according to EuroSCORE criteria)
Diabetes	hyperglycemia requiring insulin or noninsulin treatment
Chronic obstructive pulmonary disease	longterm use of bronchodilators or steroids for lung disease (according to EuroSCORE criteria)
Chronic renal failure	creatinine plasma level >1.8 mg/dL
Unstable angina	rest angina requiring i.v. nitrates until arrival in the anaesthetic room (according to EuroSCORE criteria)
S-T elevation	new ST elevation at the J-point in two contiguous leads with the cut-off points: ≥0.2 mV in men or ≥0.15 mV in women in leads V2-V3 and/or ≥0.1 mV in other leads [9]
Moderate LV dysfunction	left ventricular ejection fraction 30-50% (according to EuroSCORE criteria)
Poor LV dysfunction	left ventricular ejection fraction < 30% (according to EuroSCORE criteria)
Stroke	transient or persisting postoperative hemiparesis or neurological dysfunction with morphological substrate confirmed by computer tomography or nuclear magnetic resonance imaging
Postoperative acute renal failure	requirement for continuous veno-venous hemofiltration

Conclusions

Our study suggest that surgical coronary revascularization by the OPCABG technique in patients over 75 years with low LVEF is associated with a reduction in postoperative myocardial injury. However, at the follow-up, this does not reflect any significant differences in terms of early and late outcomes.

Riassunto

Il nostro studio ha lo scopo di confrontare gli eventi clinici ed i dati laboratoristici postoperatori di pazienti anziani coronaropatici con disfunzione ventricolare sinistra, sottoposti a rivascolarizzazione miocardica chirurgica eseguita con o senza ausilio della circolazione extracorporea. Studi recenti hanno evidenziato i vantaggi dell'intervento a cuore battente nei pazienti anziani, riportando una riduzione della morbidità postoperatoria e della disfunzione di organo. Tuttavia questi studi non analizzano l'impatto della disfunzione ventricolare sinistra sugli eventi postoperatori precoci e tardivi nei pazienti ad alto rischio.

Abbiamo esaminato retrospettivamente 90 pazienti di età superiore ai 75 anni, con frazione di eiezione preoperatoria < 50%, sottoposti a bypass aortocoronarico, senza altre procedure cardiochirurgiche associate, tra Gennaio 2000 e Luglio 2009 presso il nostro Centro. I pazienti sono stati divisi in 2 gruppi: pazienti operati senza ausilio della circolazione extracorporea (a cuore battente) e pazienti operati con l'ausilio della circolazione extracorporea (a cuore fermo). Abbiamo confrontato I livelli sierici postoperatori degli enzimi CK, CK-MB e troponina T, indici di danno miocardico, e gli eventi cerebrovascolari. La mortalità intraospedaliera totale era del 2% (2 pazienti su 90) e simile in entrambi i gruppi (p=0.8336). I livelli medi di troponina T a 6, 24, 48 ore dopo l'intervento erano significativamente più bassi nei pazienti operati a cuore battente (p=0.0001; p=0.0021; p=0.0070). Non c'era una differenza statisticamente significativa nei 2 gruppi in termini di sopravvivenza (p=0.0764) e di eventi cerebrovascolari (p=0.3016) nell'immediato postoperatorio ed a 10 anni.

I nostri risultati dunque mostrano che il non utilizzo della circolazione extracorporea nei pazienti ad alto rischio determinerebbe una più bassa incidenza di danno miocardico; tuttavia ciò sembra non influenzare a lungo termine la sopravvivenza e l'insorgenza di complicanze cerebrovascolari.

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