

Off-Pump versus On-Pump – Intermittent Aortic Cross Clamping – Myocardial Revascularisation: Single Center Experience

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ABSTRACT

The aim of this randomised, prospective study was to evaluate hospital mortality and morbidity after myocardial revascularisation, comparing on-pump coronary artery bypass graft (CABG) myocardial revascularisation versus off-pump coronary artery bypass graft (OPCAB) myocardial revascularisation in population with multivessels coronary artery disease. Sixty patients with multivessels coronary artery diseases were scheduled to undergo coronary artery bypass grafting from January 15, 2006 to June 30, 2007 in our institution. Patients were randomized to off-pump or on-pump surgery with intermittent cross-clamping of aorta and ventricular fibrillation, using the envelope method with random numbers. In the results only difference we did find postoperatively was in Creatine Kinase-MB (CK-MB) release, the amount of bleeding and intensive care unit (ICU) stay ($p < 0.05$). There was no difference between the two groups of patients regarding incidence of main morbidity and hospital mortality. In summary, we didn't find no superiority in any of the two techniques regarding on hospital mortality and morbidity.

Key words: on-pump, off-pump, myocardial revascularisation, intermittent aortic cross-clamping

Introduction

Conventional coronary artery bypass grafting (CABG) using cardiopulmonary bypass (CPB) and cardioplegic arrest or intermittent aortic cross-clamping (IAC) has for many years represented the gold standard of coronary revascularization¹⁻⁴. The price of a still and bloodless field is ultimately paid by the patient in the form of negative sequelae of CPB, including blood trauma, activation of a series of inflammatory responses, nonpulsatile flow, and possible embolization of air or debris—most particularly embolization of atherosclerotic debris from the aorta¹⁻⁵. The objective of avoiding these deleterious effects of CPB led to the rediscovery of off-pump coronary artery bypass (OPCAB) surgery.

Beating heart operations were reintroduced to routine clinical practice 20 years ago by Benetti and Bufolo^{6,7}. The pioneering in this procedures, in which anastomoses were performed on moving and bloody coronary vessels, were technically demanding, and the revascularization of the lateral wall of the left ventricle was often not feasible. After the recent development of effective devices for target vessel exposure and stabilization, OPCAB

has gained widespread use as an alternative technique and is now challenging conventional CABG as the standard for surgical therapy in myocardial revascularisation⁶⁻⁸.

The aim of this randomised, prospective study was to evaluate hospital mortality and morbidity after myocardial revascularisation, comparing CABG versus OPCAB myocardial revascularisation in population with multivessels disease.

Patients and Methods

After obtaining approval from the Medical Faculty Ethics Committee and consent from all the patients, 60 patients with coronary artery diseases were scheduled to undergo coronary artery bypass grafting (CABG) from January 15, 2006 to June 30, 2007 in our institution.

Patients with previous cardiac operations, myocardial infarction within 7 days, and concomitant heart valve diseases were excluded from the study. All the others were

randomized to off-pump or on-pump surgery with intermittent cross-clamping of aorta and ventricular fibrillation, using the envelope method with random numbers. The groups demographic and clinical profiles are presented in Table 1.

There were no significant difference between two groups in age, sex, weight, height, comorbidities, and medications. The numbers of diseased vessels were comparable in both groups. All patients were eligible for either off-pump or on-pump cardiac surgery.

General anesthesia (with the application of propofol, midazolam, atracurium, and inhaled isoflurane) without the use of epidural catheter was facilitated.

In the on-pump group, heparin was administrated at a dosage of 3 mg/kg to achieve an activated clotting time (ACT) >480 seconds. In off-pump procedures, heparin was given at a dose of 1.5 mg/kg and the target ACT was 250 to 300 seconds. Protamine was used to reverse the effect of heparin at the dose ratio of 1.5:1.

Surgical technique

Surgical access was through a full midline sternotomy in all cases.

Off-pump Group. Verticalisation of the beating heart was achieved using Starfish (Medtronic, Minneapolis, MN, USA) suction device, while Octopuss MkIII (Medtronic, Minneapolis, MN, USA) suction-stabilizer was used for local immobilization of the distal anastomosis site. The proximal anastomoses on the aorta were performed first. Lesions of the left anterior descending coronary artery were done with the pedicle of left internal thoracic artery whenever feasible.

On-pump Group. In the IAC group, moderate systemic hypothermia (32°C) was used. Ventricular fibrillation was induced electrically and the aorta was cross-clamped. The heart was vented through the main pulmonary artery. Each distal anastomosis was constructed during a single period of aortic occlusion. At completion of the coronary anastomosis, the aortic cross-clamp was released and the heart was allowed to beat while the correspond-

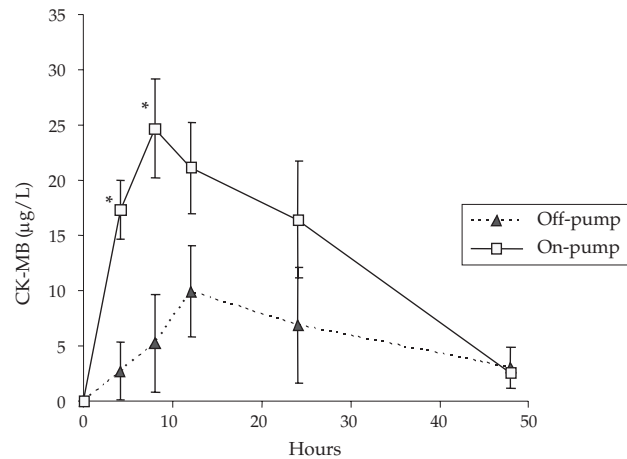


Fig. 1. Postoperative CK-MB (µg/l) after entering the Intensive Care Unit – 0, 4, 8, 12, 24, and 48 hours postoperatively in off-pump and on-pump group. CK-MB – Creatine Kinase-MB.

ing aortic anastomosis was constructed. Systemic rewarming was started during the final distal anastomosis.

Blood samples were collected from each patient immediately after entering the ICU, and then 4, 8, 12, 24, and 48 hours postoperatively.

Beside biochemical parameters we analyzed operation time, and the number of grafts performed. In addition, we recorded patients’ duration of ventilation, and duration of intensive care unit (ICU) stay. Postoperative data included myocardial infarction, bleeding, requirement for blood units, neurologic dysfunction, and atrial fibrillation for both groups.

Statistical analysis. Data are presented as mean ± standard deviation. The χ^2 -test and Fisher’s test were used to compare variables. The nonparametric Mann-Whitney test was used to calculate the difference between the two groups. Analysis was performed with MedCalc Software (MedCalc Inc., Mariakerke, Belgium).

Results

The 60 patients were divided in two groups; 30 operated on using off-pump technique (Off-pump group) and 30 operated on using on-pump technique with intermittent cross-clamping of aorta and ventricular fibrillation (On-pump group). Both the off-pump and on-pump groups showed comparable demographic characteristics. Intraoperative and postoperative data are shown in Table 2.

The total number of distal anastomosis performed in on-pump group was 2.5 ± 0.58 vs. 2.3 ± 0.34 in off-pump group. There was no significant difference between the groups in duration of mechanical ventilation (14 ± 3.16 hours in on-pump group vs. 13.5 ± 2.26 hours in off-pump-group), but ICU stay was longer in on-pump group (50.4 ± 2.09 hours in on-pump group vs. 31.2 ± 2.67 hours in off-pump-group, $P < 0.05$). Bleeding was evaluated in 24 hours postoperative period, measuring the chest tubes output. Patients operated on off-pump presented

TABLE 1
BASELINE DEMOGRAPHIC CHARACTERISTICS

	Off-pump group	On-pump group	p
N	30	30	
age	59.3 ± 7.2	62 ± 5.4	ns
female	7	10	ns
smoking	20	26	ns
previous IM	20	24	ns
hypercholesterolemia	28	30	ns
hypertension	28	24	ns
ejection fraction (%)	45	47	ns
Euro-score	3.8	3.95	ns
pulmonary diseases	10	13	ns

TABLE 2
INTRAOPERATIVE AND POSTOPERATIVE DATA

	Off-pump group	On-pump group	P
N	30	30	
Intraoperative			
operation time	155 ± 20 min	165 ± 28 min	ns
bypass time		55 ± 20 min	
coronary occlusion time		28 ± 7	
number of grafts	2.3 ± 0.34	2.5 ± 0.58	ns
left internal thoracic artery	28	27	ns
Postoperative			
myocardial infarction	0	0	–
postoperative CK-MB (µg/L)	5.57 ± 5.7	16.4 ± 8.43	p < 0.05
bleeding (mL)	352 ± 126.7	480 ± 243.8	p < 0.05
reoperation	0	1	ns
respiratory complication	2	4	ns
time of mechanical ventilation (hours)	1	14 ± 3.16	ns
neurologic dysfunction	3.5 ± 2.26	2	ns
ICU stay (hours)	1	50.4 ± 2.09	p < 0.05
in-hospital stay (days)	31.2 ± 2.67	12 ± 2.25	ns
in-hospital death	10 ± 2.3	0	–
	0		

*P value < 0.05

352 ± 126.7 mL of bleeding in postoperative period, and in on-pump group had 480 ± 243.8 mL (p < 0.05). There was one reoperation in on-pump group because of bleeding problems. Fifteen patients in off-pump group and 17 in on-pump group needed blood transfusions. There was no significant difference in the total amount of blood used. Two patients in both groups developed atrial fibrillation postoperatively.

The total amount of CK-MB released was higher in the on-pump group (16.4 ± 8.43 vs. 5.57 ± 5.7 µg/L, P < 0.005). However, CK-MB concentrations were comparable 12, 24, and 48 hours postoperatively (Figure 1).

The other postoperative parameters were comparable in both groups.

Discussion

Comparing patients with multivessels disease, Czerney and colleagues described clinical results and hospital stay as similar in both groups⁸. Several comparative studies described a number of grafts per patients significantly lower in OPCAB group^{10,11}.

In the study by Ascione and colleagues CK-MB release was significantly lower in OPCAB group, but there was no difference in myocardial infarction in either group¹². The majority of publications documented fewer bleeding, pulmonary complications, infection and shorter in hospital stay in OPCAB group^{11–14}.

In our study we found no differences in the patients' preoperative data. The same was true for intraoperative values. There was no difference in the number of grafts per patients.

The only difference we did find postoperatively was in CK-MB release, the amount of bleeding and intensive care unit (ICU) stay.

Postoperative CK-MB release was significantly lower in OPCAB group only at 4 and 8 hours, but afterwards that difference disappeared. We did not find any clinical implication in the mentioned difference.

We had significantly fewer postoperative bleeding in OPCAB group, which we explained with decreased hemostatic function in on-pump group. In addition this, we found no further differences in reoperation for bleeding or total amount of blood used.

In this study, the ICU hospital stay was significantly longer for on pump group of patients, but there was no difference in the overall hospital stay. The longer ICU stay was generated by more respiratory problems (ns) in on pump group patients and one reoperation (ns) for bleeding in the same group.

In summary, we found no superiority in any of the two techniques. There was no difference between the two groups of patients regarding incidence of main morbidity and hospital mortality. Therefore, we think that both techniques are comparable and efficient in the treatment of coronary artery diseases.

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USPOREDBA REVASKULARIZACIJE MIOKARDA TEHNIKOM »OFF-PUMP« I »ON-PUMP« SA INTERMITENTNOM OKLUZIJOM AORTE: ISKUSTVO JEDNOG CENTRA

SAŽETAK

Cilj ove randomizirane prospektivne studije je analizirati bolničku smrtnost i pobol ovisno o tehnici revaskularizacije miokarda s obzirom na uporabu izvantjelesne cirkulacije u bolesnika sa višezilnom bolesti koronarnih arterija. U studiju je uključeno 60 bolesnika podijeljenih u dvije skupine. U prvoj skupini su se nalazili bolesnici kojima je operacija izvedena bez korištenja izvantjelesne cirkulacije (»off-pump« skupina) dok su drugu skupinu činili bolesnici kod kojih je operacija izvršena uz prisustvo izvantjelesne cirkulacije te korištenja tehnike intermitentne okluzije aorte (»on-pump« skupina). Rezultati su pokazali poslijeoperacijsku razliku u vrijednostima enzima CK-MB, intenzitetu poslijeoperacijskog krvarenja i duljini boravka u Jedinici intenzivnog liječenja ($p < 0,05$). Nije uočena razlika između dvije grupe pacijenta s obzirom na incidenciju značajnijih komplikacija i bolničke smrtnosti. U konačnici, nismo našli dokaze koji bi davali prednost jednoj od navedenih tehnika, s obzirom na bolničku smrtnost i pobol.