Original Article

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OUTCOMES OF OFF-PUMP VERSUS ON-PUMP CORONARY ARTERY BYPASS GRAFTING FOR ISCHEMIC HEART DISEASE IN PATIENTS OVER SEVENTY YEARS OF AGE

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ABSTRACT

Objective: To evaluate the perioperative characteristics and short term surgical outcomes of off-pump versus on-pump CABG in elderly patients above the age of 70 years with ischemic heart disease.

Study Design: Descriptive cross-sectional study

Place & Duration of Study: This study was conducted at Army Cardiac Centre Lahore from January 2014 to December 2015.

Material and Methods: A total of 129 patients according to inclusion criteria above 70 years of age were included in the study. Patients with combined procedures (CABG with valve repair / replacement) were excluded from the study. Operative risk of all patients was assessed as per the European System for Cardiac Operative Risk Evaluation (EuroSCORE).

Results: There were 53 patients in the OPCAB group and 76 patients in the CCAB group. The OPCAB group had 6 (11.3%) females and 47 (88.6%) males whereas in CCAB group there were 7 (9.2%) females and 69 (90.7%) males. IABP was used only in CCAB group 12 (15.8%). As regards short term outcomes the OPCAB group had mean extubation time of 228 ± 188.80 min as compared to CCAB group with a mean extubation time of 395.1 ± 489.7 min p value 0.001. Mean length of stay observed in OPCAB group was shorter 3.65 ± 2.63 days against CCAB group 6.5 ± 6.9 days *p* value 0.01.

Conclusion: Off-pump (OPCAB) coronary artery bypass was associated with reduced adverse events compared with on-pump (CCAB) coronary artery bypass in patients aged >70 years with a trend towards better early survival.

Keywords: Off pump coronary artery bypass grafting, on pump coronary artery bypass grafting, length of stay.

INTRODUCTION

Coronary artery bypass grafting (CABG) is effective at reducing angina and improving survival in appropriate patients with coronary artery disease. With increasing old population and subjecting those to angiographic procedures bring more cases for surgical coronary revascularization. Although majority of the CABG procedures are performed on the arrested heart with the support of cardiopulmonary bypass CPB and the off pump technique performed on the beating heart have been developed in an attempt to avoid neurocognitive and other complications like thought to be associated with cardiopulmonary bypass[1]. High risk patients including elderly are particularly susceptible to damage initiated by CPB[2]. Off Pump Coronary Artery Bypass (OPCAB) as opposed to Conventional Coronary Artery Bypass (CCAB) is associated with short-term and long-term benefits in stroke prevention, atrial fibrillation, wound infection, acute kidney injury in patients at higher risk including the elderly as estimated by European System for Cardiac Risk Evaluation (EuroSCORE)[3,5]. The ROOBY trial documented insignificant difference between off pump and on pump CABG surgery in the primary short term end points of death or major complications at 30 days[4].

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MATERIAL AND METHODS

A descriptive cross sectional study was conducted at Army Cardiac Centre Lahore from 2014 to 2015. The study was approved by the institutional ethical review board. All the data were collected prospectively at the time of operation and entered into a database. A total of 129 patients according to inclusion criteria above 70 years of age were included in the study after informed written consent. Patients with combined procedures (CABG with valve repair/ replacement) were excluded from the study. Operative risk of all patients was assessed as per the European System for Cardiac Operative Risk Evaluation (EuroSCORE). All procedures were done through a median sternotomy incision. Left internal mammary artery (LIMA) was used as a conduit in all patients unless contraindicated. A segment of saphenous vein was used as a conduit when required.

OPCAB procedures were conducted with an activated clotting time (ACT) maintained above 300 seconds. The required vessels were exposed with the help of swabs placed under the heart and deep pericardial retraction sutures to lift the heart. Hemodynamic instability resulting from displacement of the heart during OPCAB was managed actively by the anesthetist with a combination of positioning of the operation table, intravenous fluids and pharmacotherapy. After optimal exposure and stabilization with a suction based stabilizer system Octopus 4.3 or Evolution (Medtronic,MN,USA the target vessel was opened. An appropriately sized intra-coronary shunt was placed to maintain perfusion of the dependent myocardium and distal anastomosis performed using 7/0 or 8/0 Prolene (Ethicon J&J, OH,USA) suture. Proximal anastomosis was achieved using a partial occluding vascular clamp on the ascending aorta, an aortotomy punch and 6/0 or 7/0 Prolene. The left anterior descending (LAD) artery was grafted first in most cases followed by diagonal, right coronary artery and then finally the obtuse marginal. In patients with severe coronary disease and depressed left ventricular function, proximal anastomosis of a graft was constructed prior to distal anastomosis to achieve 'functional revascularization'.

Conventional CABG was carried out with the use of CPB and an ACT maintained above 500 seconds. Cardiac arrest and myocardial protection strategies employed differed with the operating surgeons' preference. Blood based cardioplegic solution was delivered either antegrade in the aortic root, or, antegrade as well as retrograde through a cannula placed in the coronary sinus. After aortic cross clamp and arrest of the heart, all distal anastomoses were completed first. Inotropic support and intra-aortic balloon pump (IABP) was used during the weaning off process whenever required. Heparin was reversed with protamine in 1:1 ratio at the conclusion of the operation. All the patient were managed and strictly monitored postoperatively similarly in both groups. They were kept on mechanical ventilation till complete cardiorespiratory and neurological recovery.

RESULTS

A total number of 129 patients above the age of 70 years were included in the study. There were 53 patients in the OPCAB group and 76 patients in the CCAB group. The OPCAB group had 6 (11.3%) females and 47 (88.6%) males whereas in CCAB group there were 7 (9.2%) females and 69 (90.7%) males. The distribution of age in OPCAB group was 70.2 (range 70-80 yrs) as opposed to CCAB group 76 yrs (range 70-85 yrs).

The CCAB group had more number of smokers 19 (25%), and hypertensive patients 37 (48.7%) versus OPCAB group 13(24.5%) and 19(25%). The mean ejection fraction in OPCAB group was 50.7% ± 10.27 whereas CCAB group had a lower mean EF 47.4% ± 15.56.

IABP was used only in CCAB group 12 (15.8%). As regards short term outcomes the OPCAB group had mean extubation time of 228 ± 188.80 min as compared to CCAB group with a mean extubation time of 395.1 ± 489.7 min p value 0.001. Mean length of stay observed in

Table-1: Demographic, Clinical, per and post-operative characteristics of group A and group B

Sr. #	Variables	Group A (Off pump) n = 53	Group B (On pump) n = 76	*p* value
	Demographic Characteristics			
1.	Age (mean, range) years	70.2, 70-80	76.0, 70-85	0.5
2.	Gender n(%) Males Females	 47 (88.6%) 6 (11.3%)	 69 (90.7%) 7 (9.2%)	 0.55 0.42
3.	Weight (mean ± SD) kg	70.03 ± 1.19	74.87 ± 1.41	0.7
	Clinical Characteristics			
4.	Co-morbids Hypertension Diabetes Mellitus	 34 (64.2%) 18 (34%)	 37 (48.7%) 18 (23.7%)	 0.6 0.9
5.	Smokers	13 (24.5%)	19 (25%)	0.6
6.	Euro SCORE	6.2 ± 2.04	4.12 ± 2.51	0.1
7.	CCS class	2.16 ± 0.37	2.05 ± 0.63	0.8
8.	NYHA class (mean ± SD)	2.15 ± 0.41	1.98 ± 0.68	0.61
9.	LV ejection fraction (mean ± SD)	50.73 ± 10.27	47.48 ± 15.56	0.42
10.	Poor LV function n(%)	5 (9.4%)	5 (6.6%)	0.65
	Per-Operative Parameters			
11.	Lima graft n (%)	40	65 (85%)	0.5
12.	Vein graft (mean± SD)	2.15 ± 0.93	2.21 ± 1.09	0.8
13.	Antegrade cardioplegia n (%)	-	60 (78.9%)	
14.	Ante & retrograde cardioplegia n (%)	-	16 (21.1%)	
15.	Endarterectomy n(%)	-	4 (5.3%)	
16.	Bypass time (mins) (mean± SD)	-	112.05 ± 53.09	
17.	Cross clamp time (mins) (mean± SD)	-	65.37 ± 36.60	
18.	IABP n (%)	-	12 (15.8%)	
	Post operative parameters			
19.	Extubation time (mean± SD) mins	228.6 ± 188.80	395.19 ± 489.75	0.001
20.	Length of stay (mean± SD) days	3.65 ± 2.63	6.5 ± 6.9	0.01
21.	Fever n (%)	5 (17%)	15(27.6%)	0.02
22.	Sternal Infections n (%)	5 (17%)	0 (0%)	0.006
23.	Re opening n (%)	4 (7.5%)	21(14.5%)	0.001
24.	Dialysis n (%)	1 (1.9%)	4(5.3%)	0.06
25.	Mortality n (%)	3 (5.7%)	8(10.5%)	0.03
26.	Stroke	0 (0%)	5 (6.57%)	0.01

OPCAB group was shorter 3.65 ± 2.63 days against CCAB group 6.5 ± 6.9 days *p* value 0.01.

The number of post-operative mediastinal exploration was relatively higher in CCAB group 21 (14.5%) versus OPCAB group 4 (7.5%) *p* value 0.001. However, the incidence of surgical site infections was higher in OPCAB group 5 (17%) p value 0.006. A trend toward higher postoperative mortality was observed after CCAB 8 (10.5%) opposed to OPCAB group 3 (5.7%) *p* value 0.03.

DISCUSSION

Although OPCAB surgery is regarded as a recent advancement in the treatment of ischemic heart disease, but history suggests the initial surgical procedures were performed on beating heart[6]. Favalaro popularized the coronary artery bypass with saphenous vein grafts using heart lung machine in late sixties[7]. With the advancement of perfusion technology and myocardial protection techniques, most of the surgeons preferred on-pump surgery with a still heart and blood less field. During cardiopulmonary bypass blood is exposed to synthetic surfaces and shear forces of the pump leading to a whole body inflammatory response which can have potential deleterious effects of varying degrees leading to dysfunction of brain, lungs, kidneys and heart[2,3]. Embolization of air, particulate matter from atherosclerotic aorta, heart or bypass circuit is another source of complications.

Age is an independent risk factor in patients undergoing coronary artery bypass surgery. Various authors have documented that the off-pump bypass is beneficial in elderly patients and patients with high comorbid conditions[7]. The elderly patients not only carry comorbidities but also have severe coronary artery disease[8]. With advances in interventional cardiology there has been drop in potential candidates for isolated coronary artery bypass surgery resulting in shift for high risk cases for bypass surgery. Avoiding cardiopulmonary bypass can be beneficial in this group as the side effects of the pump as well metabolic stress are avoided. It is well known that elderly are particularly susceptible to effects of inflammatory mediators. Most of the published papers reported similar in hospital mortality for CCAB and OPCAB procedures[9]. However some recent non randomized studies have shown that mortality is higher in patients operated on cardiopulmonary bypass. In our study, the mortality in the off-pump group was 5.7% and in on-pump group it was 10.5%. All patients in group A were with EoroSCORE >5 with age more than 70, implying a higher risk group. The mortality was less than the predicted from the EuroSCORE. Such a trend has also been endorsed by Houlind et al in results from the Danish On-Pump Versus Off-Pump Randomization Study[10].

Another matter of debate is that the bypass surgery is associated with adverse neurological complications. Off pump surgery has been suggested to decrease the incidence of stroke[11-13]. There was no case of stroke in the off-pump group and there were significant number in the on-pump group who suffered cerebrovascular accidents. Most of the studies have shown stroke rate ranging from 1% to 5% of the patients. Elderly age is recognized as an independent predictor of stroke related to the prevalence of diseased aorta[14]. ROOBY trial has shown a trend in the opposite direction. Although in our study the number of patients is small, careful handling of aorta during proximal anastomosis is key to avoid this complication.

In “On and Off Cardiopulmonary Bypass (ROOBY)” trial, 2,203 patients at 18 participating VA medical centers were randomly assigned to undergo either on-pump or off-pump CABG. There was no significant difference between treatment groups in the rates of the 30-day composite outcome of death or complications (reoperation, new mechanical support, cardiac arrest, coma, stroke, or renal failure) (7.0% and 5.6%, respectively; *p*=0.19)15. In our study, perioperative myocardial infarction was observed in 3.7% cases in off-pump group compared to 5.3% in on-pump group. There is growing body of evidence that as cited by Parolari and Reston in meta-analyses that this approach seems to reduce transfusion and inotropes requirements, mechanical support,

ventilation time, intensive care unit and hospital stays, in hospital and one year direct costs[16,17]. Other studies also substantiate this effect with OPCAB surgery[18-22].

Use of intra-aortic balloon pump (IABP) was higher in on-pump group required to deal with low cardiac output syndrome (15.8% vs 0%). Similarly the extubation time was less in of-pump patients compared to group B (188.8 min vs 489.7 min). The hospital stay was shorter in group A compared to the group B (3.65 days vs 6.5 days). The reopening for post-operative bleeding was more in on-pump group (14.5%) than off pump group (7.5%).

Renal dysfunction is a serious complication after CABG with CPB due to non-pulsatile flow on pump, hemolysis, systemic inflammatory response and emboli[23]. Moreover old age is an important predictor of renal dysfunction after coronary artery bypass surgery[24]. Ajuna Weerasinghe, in is his propensity based study on consistent patients confirmed these findings but a meta-analysis of six randomized controlled trials and 16 observational studies failed to demonstrate the benefit of OPCAB and renal failure[25]. Four (5.3%) patients developed acute renal failure in on-pump group requiring hemodialysis compared to one (1.9%) in off-pump group in our study.

CONCLUSIONS

Current results indicate that Off-pump (OPCAB) coronary artery bypass was associated with reduced adverse events compared with on-pump (CCAB) coronary artery bypass in patients aged >70 years with a trend towards better early survival. However, suboptimal quality of the available studies, particularly the lack of comparability of the study groups, prevents conclusive results on this controversial issue.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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