MEDIASTINAL BLEEDING AND BLOOD TRANSFUSIONS IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS SURGERY PERFORMED WITH OR WITHOUT CRDIOPULMONARY BYPASS

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ABSTRACT

Objective: To determine the rate of postoperative bleeding and blood transfusions in patient undergoing coronary artery bypass surgery for coronary artery disease during OPCAB or conventional CABG.
Study Design: Comparative cross-sectional study.
Place and Duration of Study: Adult Cardiac Surgery Departments of Armed Forces Institute of Cardiology & National Institute of Heart Disease (AFIC/NIHD) Rawalpindi, Pakistan from 1 July 2017 to 31 Dec 2017.
Material and Methods: Two hundred patients undergoing coronary artery bypass surgeries performed with (Conventional CABG) or without cardiopulmonary bypass.
(Off pump CABG /OPCAB) were enrolled in the study and were divided into two equal groups. All procedures were elective. Careful monitoring was carried out on hourly basis. The rate of postoperative chest drainage and number of blood transfusions received were measured in both groups.
Results: As compared to the OPCAB group, the patients in CPB group required ion tropic support for a longer duration (29.6 ± 65.1 vs 60.9 ± 71.2, *p*-value <0.02). Similarly, the rate of chest drainage was significantly higher in conventional CABG Vs OPCAB (45% vs 30% *p*<0.026). Requirement of blood transfusion (RCC) was significantly higher in conventional CPB vs OPCAB group (1.6 ± 1.6 vs 1.0 ± 1.2, *p*-value 0.04). Mechanical ventilation time was almost same in both groups with median value of 6 hours.
Conclusions: Our study concluded that the main advantages of OPCAB technique are that there is less amount of postoperative chest drainage and it makes it possible to decrease the number of blood transfusions after surgery.

Keywords: Blood transfusion, Coronary artery bypass grafting, Cardiopulmonary bypass, Off-pump coronary artery bypass, On-pump coronary artery grafting, Red cell concentrate.

INTRODUCTION

Ischemic heart disease is one the leading causes of death in the world[1,2]. Coronary artery bypass grafting (CABG) remains the standard treatment option in patients with extensive coronary artery disease[3]. The majority of cardiac procedures are carried out using the cardiopulmonary bypass (CPB), but those performed without, in the recent years, have relatively less rate of complications, as these avoid systemic inflammatory response syndrome (SIRS) produced by the use of extracorporeal circuit[4-6]. This systemic inflammation can involve many organs and is usually self-limiting.

There is an ongoing debate regarding the clinical outcomes after on-pump versus off-pump coronary artery bypass (ONCAB versus OPCAB) surgery and postoperative bleeding remains a major concern.

The aim of this retrospective study is to compare the effect of CPB, either used or not, on the rates of postoperative bleeding and packed red cell transfusions after coronary surgery, as these are closely related with increased hospital mortality and morbidity, patients survival, blood transfusion reactions, wound infections and sepsis[7-9].

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MATERIAL AND METHODS

Patients

All patients below the age of 70 years who underwent elective isolated CABG surgery using a median sternotomy approach at a tertiary care cardiac facility, between July 2017 and December 2017 were acquired from the adult cardiac surgery database. The decision to perform the operation, either on-pump or off pump was made by the operating surgeon. Patients with age of more than 70 years, redo surgeries, cases who were intended to be operated off-pump but were later converted to on-pump after initiation of coronary grafting, those having difficult coronary anatomy ending up in endarterectomy or venous patch plasty and patients with lateral thoracotomy incisional approaches were excluded. The study was approved by the hospital's institutional ethical review board.

This study included 200 patients, 100 patients underwent coronary surgery with CPB (group-1) and 100 cases were subjected to OPCAB grafting (group-2). All patients included in the study were subjected to full history, local and general physical examination, routine laboratory investigations, imaging studies before surgery that included Chest x-rays, 2D-Echoes, Carotid Doppler.

The primary endpoints of interest were packed red blood cell transfusions, re-operation rate for bleeding or cardiac tamponade, and 12 h and total postoperative chest tube drainage. Pre-operative parameters which were analyzed included age, gender, Body Mass Index (BMI) and co-morbid conditions, whereas operative characteristics included cardiopulmonary bypass time and cross clamp time.

Pre-operative Considerations

In both groups, patients were using dual antiplatelet therapy in the form of Aspirin and Clopidogrel pre-operatively, which was stopped 3 days and 5 days before operation respectively. No patient received oral or parenteral anti-coagulants before surgery.

Anesthesia and Anticoagulation Management

Patients in both groups, undergoing OPCAB or conventional CPB surgery, received the same anaesthetic regimen. In CABG group, before initiation of CPB, a bolus dose of 300-400 IU/kg of heparin was given to achieve a kaolin activated clotting time (ACT) of at least 480 seconds. Additional heparin was infused on CPB if required. After termination of CPB, 3-4 mg/kg protamine was given to fully reverse the anticoagulant effect of heparin. In the OPCAB group, 150 IU/kg of heparin was administered before division of the internal mammary artery to maintain an ACT of 250-350 seconds. On completion of anastomoses in patients undergoing OPCAB, 0.75 mg/kg protamine was given to partially reverse the heparin. Anti-fibrinolytics in the form of alpha aminocaproic acid were injected at the surgeon's discretion.

Operative and Perfusion Procedure

OPCAB surgery was performed through a median sternotomy approach. Stabilization of the target coronary artery was achieved by using either a compression device or suction apparatus. Operative blood was aspirated into a blood salvaging system to be concentrated, washed, and transfused if enough was collected. A perfusionist remained on standby for emergency institution of CPB if required. While, surgery in CPB group was performed through a full sternotomy incision using a membrane oxygenator and a roller pump. The circuit was primed with 2200 mL of Hartman solution or 1700 mL Hartman and 500 mL 4% albumin solution with 10,000 units of heparin. An addition of 10 g of mannitol was made while priming the circuit of CPB in patients who had a preoperative creatinine of >0.15 mmol/L. Institution of CPB was achieved by cannulating the ascending aorta and right atrium. After cross-clamping, antegrade or retrograde blood cardioplegia was infused for myocardial protection of the arrested heart. Minimum systemic temperatures ranged from 28°C to 34°C. Perfusionist preference determined whether all or part of the cardiotomy blood was

returned to the CPB circuit or collected in a cell-saving device for subsequent processing. After weaning from CPB, the residual blood in the extracorporeal circuit was salvaged and processed either through a cell-saving device or simply bagged before patient reinfusion. At least two chest drains were inserted in the pericardium and pleura if internal mammary arteries were harvested. These drains were connected to a low suction system (-20 cm H_2O) after closure of the chest. Total chest drainage was recorded as the volume of blood in the collection receptacle from closure of the chest until removal of the chest drains.

Postoperative Care

Treatment of patients undergoing on-pump or off-pump coronary surgeries followed a standardized care from operation to discharge irrespective of the type of procedure performed.

Transfusion Protocol

For patients in both groups, the decision to transfuse homologous packed RBCs was based on the patient's clinical assessment like pulse, blood pressure, urine output and/or a haematocrit (Hct) level (<20%). Postoperatively, blood transfusions were given when hemoglobin level fell to <10 g/dL.

Table-I: Clinical characteristics and demographics (CPB vs OPCAB).

Variables	CPB n=100	OPCAB n=100
AGE (Mean ± SD)	57.5 ± 8.9	59.1 ± 7.2
Gender n(%)		
Male	85 (84.2%)	76 (76%)
Female	16 (15.8%)	24 (24%)
BMI (Mean ± SD)	27.0 ± 4.1	29.2 ± 5.4
NYHA Class		
I	28 (28 %)	23 (23%)
II	29 (29%)	34 (34%)
III	43 (43 %)	43 (43%)
IV	NIL	NIL
Hypertension	54 (54 %)	52 (52%)
Diabetics	46 (46 %)	44 (44%)
Smoking		
Ex-Smokers	21 (21 %)	25 (25%)
Current Smokers	11 (11%)	7 (7%)

Table-II: Angiographic data (CPB vs OPCAB).

Variable	CPB n=100	OPCAB n=100
Extent of Coronary artery disease		
Single vessel	2 (2%)	5 (5%)
Double vessel	14 (14%)	20 (20%)
Triple vessel	84 (84%)	75 (75%)
Left Main stem disease >70%	17 (17%)	15 (15%)

Reoperation Protocol

Re-exploration was performed if bleeding exceeded 400 mL/0.5 h, >300 mL/h, or >200 mL/h for 2 hours despite correction of any coagulopathies. Re-operations were also indicated if there were clinical signs of cardiac tamponade such as tachycardia, increasing central venous pressures, or decreasing urine output, usually associated with a sudden reduction in chest tube drainage.

Data Collection and Statistical Analysis

Statistical analyses were performed using SPSS version 23 with two tailed tests performed and a *p*-value<0.05 was considered significant. Data are summarized as the mean ± SD for continuous variables and as frequency and percentages for categorical variables. The two groups (CPB or CABG vs OPCAB) were compared using the Chi-square or Fisher exact test for categorical data and unpaired t tests.

group, while 54 (54%) patients were hypertensive in the CPB group. In OPCAB group, 44 patients (44%) were known to be diabetic and the number was 46 (46%) in CPB group. 7 (7%) were smokers in OPCAB patients and there were 11 (11%) smokers in group-2. In OPCAB group, 23 patients (23%) had NYHA class I, 34 patients (34%) had NYHA class II, and 43 (43%) patients were having NYHA class III symptoms. While in CABG group, 28 patients (28%) had NYHA class

Table-III: Intra operative data (CPB vs OPCAB).

Variable	CPB n=100	OPCAB n=100	*p*-value
Ionotropic support (in Hrs) (Mean ± SD)	60.9 ± 71.2	29.6 ± 65.1	0.02
Chest Drain N (%) Less than 800 ml More than 800 mI	51 (51%) 49 (49%)	70 (70%) 30 (30%)	0.02
Blood Transfusion (RCC) Requirement (Mean ± SD)	1.6 ± 1.6	1.0 ± 1.2	0.04
Ventilation Time (in hrs) (Mean ± SD)	12.9 ± 25.2 (6)	10.6 ± 23.4 (6)	0.07

Table-IV: Post-operative complication (CPB vs OPCAB).

Variable	CPB n=100	OPCAB n=100	*p*-value
Re-exploration for bleeding N (%)	12 (12%)	2 (2%)	0.02
ICU Stay Time (in hrs) (Mean ± SD)	67.6 ± 74.0	51.0 ± 78.5	0.04
Mortality N (%)	6 (5.9%)	5 (5%)	0.93

RESULTS

Of the total 200 patients, 100 cases were included in each CABG or CPB group. Patients in both groups were similar in terms of demographic features, pre-operative characteristics, re-do operations and incidence of co-morbid conditions. In OPCAB group, there were 76 males (76%) and 24 females (24%) with a mean age of 59.1 ± 7.2 years, whereas, in CPB group, there were 85 males (85%) and 16 females (16%), with a mean age of 57.5 ± 8.9 years. Fifty two patients (52%) had hypertension in OPCAB

I, 29 patients (29%) had NYHA class II, and 43 (43%) cases were in NYHA class III (table-I).

The patients in CPB group had tendency to have multi-vessel disease than those in OPCAB (off pump) group. In CPB group, there were 85 patients (85%) who had triple vessel disease vs 75 (75%) patients in OPCAB group, 20 patients (20%) had double vessel disease in OPCAB vs 14 patients (14%) in CPB; however, there were only 5 patients (5%) who had single vessel disease in OPCAB vs 2 patients (2%) in CPB group. In addition, the left main disease was almost same

among the off pump group 15 (15%) and 17(17%) patients in group-1. Results are shown in table-II.

As compared to the OPCAB group, the patients in the CPB group required ionotropic support for a longer duration (29.6 ± 65.1 vs 60.9 ± 71.2, *p*-value<0.02). Similarly, the rate of postoperative chest drainage was significantly higher in CPB Vs OPCAB (49% vs 30% *p*<0.026). Requirement of blood transfusion product (RCC) was significantly higher in CPB group as compared to OPCAB patients (1.6 ± 1.6 vs 1.0 ± 1.2, *p*-value 0.04). Mechanical ventilation time was almost same in both groups with median value of 6 hours. Results are shown in table-III & figure.

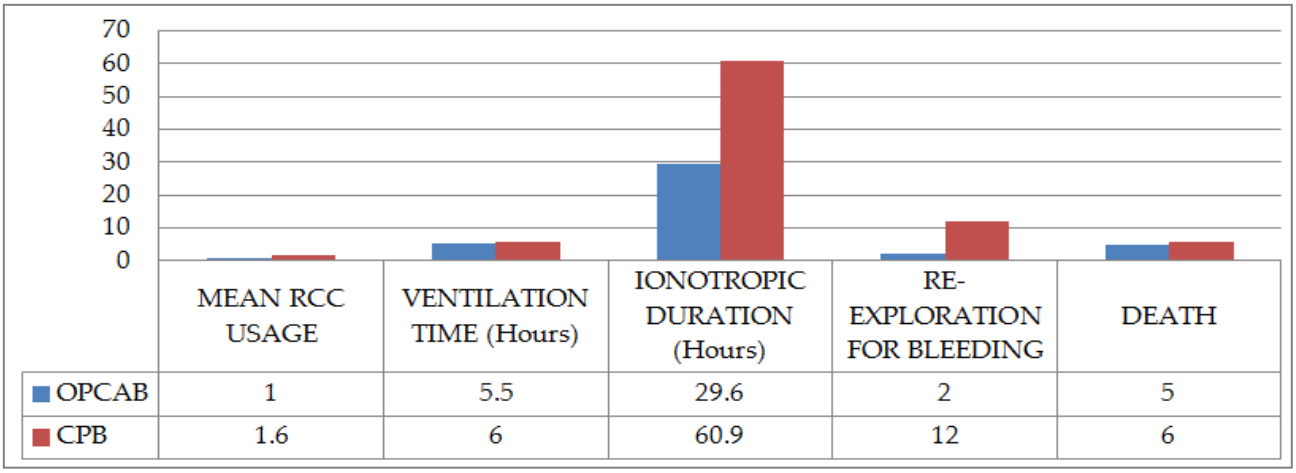

Figure: Comparison of OPCAB and coronary surgeries with CPB.

There was significantly high incidence of early postoperative complications among patients in CPB compared to those in OPCAB as regards to incidence of complete revascularization (12% vs 2%, *p*<0.02). Similarly, hospital stay was higher in CPB group as compared to OPCAB group (67.6 ± 74.0 vs 51.0 ± 78.5 hours < *p*<0.04), respectively. Mortality in both groups was found to be statistically insignificant (5.9% vs 5%, *p*<0.93). As shown in table-IV and fig.

DISCUSSION

Off-pump surgery has evolved into the most frequently adopted alternative technique to conventional on-pump coronary artery bypass grafting (CABG) in the treatment of patients with advanced coronary artery disease (CAD) over the last two decades. It has even become the procedure of choice for some surgeons, who believe that off-pump CABG is associated with lower occurrence of perioperative complications due to avoidance of cardiopulmonary bypass (CPB) and reduced or lack of manipulation of the ascending aorta. A rise in the number of off-pump CABG procedures in the late nineties and the earlier half of the first decade of the new millennium set off a never-ending debate regarding the benefits and drawbacks intrinsic to the two techniques of coronary artery grafting. Several randomized controlled trials (RCTs) have been conducted to compare the outcomes of off-pump as regards to on-pump CABG procedures[10,11].

Most trials demonstrated no difference in immediate outcomes between the two CABG techniques. Nevertheless, the two major RCTs, the Randomized On/ Off Bypass (ROOBY) trial and the Danish On-pump versus Off-pump Randomization Study (DOORS) revealed a significantly higher rate of the primary composite outcome including all-cause mortality, repeat revascularization (RR), or nonfatal myocardial infarction (MI) at 1 year and an inferior graft patency at 6 months following surgery in patients, who underwent off-pump CABG, respectively[12].

In contrast, other important RCTs such as the CABG Off- or On-Pump Revascularization Study

(CORONARY) and the Surgical Management of Arterial Revascularization Therapies (SMART) trial identified no differences in mortality, stroke, MI, RR and quality of life between off-pump and on-pump CABG at a follow-up of 1 year[13]. The latter study also showed similar angiographic patency rates. The efficacy of these RCTs to detect and assess differences in clinically important outcome measures between the two operative techniques has been questionable[14].

In the present study, there was a reduction in the requirement of blood transfusions in the OPCAB group, as compared to the CPB group. Previous studies have revealed that CPB was associated with increased demand for blood transfusions but did not investigate the contribution of intraoperative hemodilution[15]. Other studies have speculated that their observed increased blood transfusion rate for on-pump compared to off-pump patients was caused by an increased postoperative bleeding[16].

Our study reported a higher postoperative ICU stay and re-exploration rate in the conventional CABG group as compared to OPCAB group. The evidence in the literature seems to support these findings that Off-pump coronary artery bypass has been associated with a significant reduction in the risk of death, stroke, acute renal failure, mortality or morbidity, and postoperative length of hospital stay compared with on-pump coronary artery bypass surgery[17-20].

CONCLUSION

Our study concluded that the main advantages of OPCAB technique are that there is less amount of postoperative chest drainage and it makes it possible to reduce the number of blood transfusions after surgery.

LIMITATION OF STUDY

This retrospective review failed to show intraoperative haematocrit (Hct) as a marker of hemodilution that provides a more complete understanding of the mechanism of the need for blood transfusions after cardiac surgery. Addressing intraoperative hemodilution is a very important issue in minimizing CPB associated morbidities.

CONFLICT OF INTEREST

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

REFERENCES

1. Walczak M, Urbanowicz T K, Tomczyk J. Transfusion of blood products in off-pump coronary artery bypass and conventional coronary artery revascularization. A prospective randomized study. Kardiochir Torakochirurgia Pol 2014; 11(2): 136-39.
2. Sadowski J, Kapelak B, Wierzbicki K. Coronary artery disease–classic and modern surgical treatment. Terapia 2003; 3: 4-8.
3. Fudulu D, Benedetto U, Pecchinenda GG. Current outcomes of off-pump versus on-pump coronary artery bypass grafting: evidence from randomized controlled trials. J Thorac Dis 2016; 8(Suppl 10): S758-S771.
4. Wites MM. Zastosowanie krwi i jej preparatów w kardiochirurgii – stan aktualny i kierunki rozwoju w oparciu o 20-letnie obserwacje kliniczne. Magazyn Medyczny 1999; 4: 13-14.
5. Rogowski J, Jarmoszewicz K, Siondalski P, Pawlaczyk R. Opieka pooperacyjna po zabiegach kardiochirurgicznych. Choroby Serca i Naczyń 2006; 3: 115-22.
6. Raja SG, Husain M, Popescu FL, Chudasama D, Daley S, Amrani M. Does off-pump coronary artery bypass grafting negatively impact long-term survival and freedom from reintervention? Biomed Res Int 2013; 2013: 602871.
7. Michalopoulos A, Tzelepis G, Dafni U, Geroulanos S. Determinants of hospital mortality after coronary artery bypass grafting. Chest 1999; 115(6): 1598-603.
8. Engoren MC, Habib RH, Zacharias A, Schwann TA, Riordan CJ, Durham SJ. Effect of blood transfusion on long-term survival after cardiac operation. Ann Thorac Surg 2002; 74: 1180-6.
9. Daweirwala PM. Current outcomes of off-pump coronary artery bypass grafting: Evidence from real world practice. J Thorc Dis 2016; 8(Suppl 10): S772-S786.
10. Shroyer AL, Frederick L, Grover FL, Hattler B, Joseph F, Gerald O, et al. On-pump versus off-pump coronary artery bypass surgery. N Engl J Med 2009; 361: 1827-37.
11. Houlind K, Kjeldsen BJ, Madsen SN, Rasmussen BS, Holme SJ, Nielsen PH, et al. On-pump versus off-pump coronary artery bypass surgery in elderly patients: results from the Danish On-Pump versus Off- Pump Randomization Study. Circulation 2012; 125(20): 2431-9.
12. Lamy A, Devereaux PJ, Prabhakaran D, Davaid P, Hu S, Paolasso E, et al. CORONARY Investigators. Effects of off-pump and on-pump coronary-artery bypass grafting at 1 year. N Engl J Med 2013; 368: 1179-88.
13. Houlind K, Fenger-Grøn M, Holme SJ, Kjeldsen BJ, Madsen SN, Rasmussen BS, et al. Graft patency after off-pump coronary artery bypass surgery is inferior even with identical heparinization protocols. Results from the Danish On-pump Versus Off-pump Randomization Study (DOORS). J Thorac Cardiovasc Surg 2014; 148: 1812-19.
14. Dhurandhar V, Saxena A, Parikh R, Vallely MP, Wilson MK, Butcher JK, et al .Outcomes of On-Pump versus Off-Pump coronary artery bypass graft surgery in the High Risk (AusSCORE > 5). Heart Lung Circ 2015; 24(12): 1216-24.
15. Ayman El, Naggar AE, Rania M, Hoseiny E, Mohamed Y. Off pump vs on pump coronary artery bypass grafting:

Perioperative complications and early clinical outcomes. Egyptian Heart J 2012; 64(1): 43-47.
16. Shroyer AL, Grover FL, Hattler B, Collins JF, McDonald GO, Kozora E, et al. Veterans Affairs Randomized On/ Off Bypass (ROOBY) Study Group. On-pump versus off-pump coronary-artery bypass surgery. N Engl J Med 2009; 361(19): 1827-37.
17. Yousuf-ul-Islam M, Ahmed MU, Khan MS, Bawany FI, Khan A, Arshad MH et al. On Pump coronary artery bypass graft surgery versus Off pump coronary artery bypass graft surgery: A Review. Global J Health Sci 2014; 6(3): 186-93.
18. Rogers CA, Pike K, Campbell H, Reeves BC, Angelini GD, Gray A, et al. Coronary artery bypass grafting in high-Risk patients randomized to off-or on-Pump surgery: A randomized controlled trial (the CRISP trial). Health Technol Assess 2014; 18(44): 1-157.
19. Hlavicka J, Straka Z, Jelinek S, Budera P, Vanek T, Maly M, et al. Off-pump versus on-pump coronary artery bypass grafting surgery in high-risk patients: PRAGUE-6 trial at 30 days and 1 year. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 2016; 160: 263-70.
20. Cheng DC, Bainbridge D, Martin JE, Novick RJ. Does off-pump coronary artery bypass reduce mortality, morbidity, and resource utilization when compared with conventional coronary artery bypass? A meta-analysis of randomized trials. Anesthesiology 2005; 102(1): 188-203.

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