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Comparative Study of Pulmonary Artery Catheter vs Central Venous Catheter in Coronary Artery Bypass Grafting Surgery Patients

Nirav Parikh[1], Jeevraj Rajawat[2], Deepal Prajapati[3], Ramesh Patel[4], Himani Pandya[5]

[1,3]Assistant Professor, [4]Professor and Head, Department of Cardiac Anesthesia, [5]Research Associate, Department of Research, U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat 380016, India. [2]Assistant Professor, Department of Cardiac Anesthesia, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan 302022, India.

Abstract

Background: Pulmonary artery catheter and central venous catheter are an important and integral part of hemodynamic monitoring during coronary artery bypass grafting. *Methods:* In our prospective randomized survey, 180 patients received either pulmonary artery or central venous catheter after induction of anesthesia. Patients between 35 and 75 years with ejection fraction between 35 and 60% undergoing elective off pump coronary artery bypass grafting surgery were included. Both groups were compared regarding heart rate, mean arterial pressures, serum lactate and central venous saturation, need for inotropes, fluid challenge, blood and blood products use, postoperative complications and ICU stay. *Results:* There is no statistical difference in heart rate and mean arterial pressure in intra- and postoperative period in both CVC and PA group except in PA group where heart rate was significantly lower after grafting and mean arterial pressure was higher at T6 and T12 hrs. After 48 hours blood lactate level was significant lower in PA catheter groups. Both groups were similar in terms of central venous saturation, intraoperative fluid bolus use, blood, blood products use and output both intraoperative and postoperatively. Use of inotropes particularly noradrenaline and levosemandan was more in PA group. There was no statistically significant difference in respiratory, CNS and Renal complications (*p* value >0.05), ICU stays >48 hr and mortality in both groups. *Conclusion:* We can conclude from our study that PAC definitely provides additional information regarding cardiac output and cardiac index in comparisons with CVC but clearly it does not result in significant difference in postoperative ICU stay and outcome of patient in form of morbidity and mortality in coronary artery bypass patients with preserved LV function.

Keywords: Central venous catheter; Pulmonary artery catheter; Coronary artery bypass graft; Peripheral vascular disease.

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Introduction

The introduction and initiation of substantial hemodynamic monitoring ushered the successful era of coronary artery bypass grafting surgery. With further knowledge in medical monitoring, ever-increasing stress has been placed on establishment of a central venous catheter (CVC) and pulmonary artery catheter (PAC) for hemodynamic monitoring. In the last decade, PAC monitoring has become less common with the newer advanced methods of cardiac output monitoring, but it is still considered as standard method for hemodynamic monitoring during coronary artery bypass graft (CABG).[1,2] On one hand, The CVC gives an idea

Corresponding Author: Jeevraj Rajawat, Assistant Professor, Department of Cardiac Anesthesia, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan 302022, India.

E-mail: jeevrajrajawat@yahoo.com

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about fluid status but does not provide extensive hemodynamic information as PA. Advocates of routine PA catheter use cite the advantages of early detection of hemodynamic deterioration[3–5], precise monitoring of the effect of therapeutic interventions and evidence that mortality is related to indices of myocardial function, namely the cardiac index, measured with a PA catheter.[6]

For patients who undergo coronary artery bypass graft (CABG) surgery, the PAC remains the most frequently used monitor among cardiovascular anesthesiologists.[7] The PAC has been considered to be a valuable device in perioperative fluid and vasoactive drug management, for early detection of perfusion abnormalities potentially for establishing tissue hypoxia. The CVC is still considered a cost-effective monitoring tool for management of CABG. Also there are very few studies which include the patients undergoing CABG with proper unbiased patient selection with randomization which can decide if PAC or CVC is the desirable monitoring tool for both intraoperative and postoperative management of patients including in terms of morbidity and mortality.

So our aim of the study is to conduct prospective survey to compare PA catheter with CVP catheter in patients undergoing coronary artery bypass grafting in terms of intraoperative and postoperative management.

Materials and Methods

In our single centered prospective randomized study, 180 patients undergoing elective off pump coronary artery bypass grafting (CABG) between February 2015 and February 2016 were randomly divided into two groups by computerized method. Institutional ethics committee approval was taken and written informed consent from patients was obtained. Group A and Group B received Pulmonary artery (PA) catheter and Central venous catheter (CVC) respectively.

Inclusion criteria

Patients between 35 and 75 years with ejection fraction between 35 and 60%, with or without controlled systemic disease were included.

Exclusion criteria

Patient with recent (less than 24-hour) or ongoing myocardial infarction or if combined surgical procedures (including valve or ascending aorta procedures) or redo-operations were excluded. Patients with planned off-pump CABG surgery were excluded.

Patients with age more than 75 years or less than 35 year, severe left ventricular dysfunction (EF <35%), on intra-aortic balloon pump, post- Myocardial infarction ventricular septal rupture, ischemic MR, significant renal and hepatic dysfunction, neurological abnormality, peripheral vascular disease (PVD) and preoperative coagulation abnormality were excluded from the study.

All patients were given Tab. Alprazolam and Inj. Pantoprazole night before surgery.

Beta-blockers and other drugs except angiotensin-receptor blocker drugs were continued until the morning of surgery in all patients, and oral anti-diabetic agent like sulfonylureas was stopped and replaced with insulin at the time of hospital admission.

In all patient inj midazolam 0.05 mg/kg was given as premedication half an hour before surgery in preoperative room under close supervision of vitals.

Peripheral line and radial arterial line were inserted under local anesthesia prior to induction under aseptic precautions.

Anesthesia was induced in all patients by the administration of 0.1 mg/kg Midazolam, 5 µg/kg fentanyl and 0.2 mg/kg vecuronium bromide. After 3 min, patients underwent oral endotracheal intubation. In all patient CVC or PA catheter was put in right internal jugular vein after induction by Seldinger method. Intraoperatively, patients were administered 1 µg/kg Fentanyl, 0.04 mg/kg Vecuronium and Sevoflurane for maintenance of anesthesia.

All the patients were treated with 2 mg/kg heparin sodium for anticoagulation and protamine was used for heparin neutralization.

Heart rate (HR), Mean arterial pressure (MAP), Central venous oxygen saturation ($SvCO_2$) and Serum lactate in both groups was observed intraoperative after induction (AI), before grafting (BG) and after grafting (AG) and postoperative (T1) 1 hour (hr), (T6) 6 hr, (T12) 12 hr, (T18) 18 hr, (T24) 24 hr, (T36) 36 hr and (T48) 48 hr after surgery in postoperative ICU. In CVC group central venous pressure (CVP) was observed and in PA group CVP, Pulmonary capillary wedge pressure (PCWP), Cardiac output (CO) monitoring was done by thermodilution method and CO variable like Cardiac Index (CI) was observed

after induction, before grafting and after grafting during intraoperative and post operative at (T1) 1 hr, (T6) 6 hr, (T12) 12 hr, (T18) 18 hr, (T24) 24 hr, (T36) 36 hr and (T48) 48 hr after surgery in postoperative ICU. CVP and PCWP were maintained between 8 and 12 mm of Hg and 12 and 15 mm Hg respectively in both groups throughout perioperative period. Infusion of Inj. nitroglycerine was used for coronary vasodilation and to control perioperative hypertension. Hypotension was corrected first by giving fluid challenge with 250–300 ml crystalloids and if failed, either inotropes noradrenaline or dobutamine were started and/or blood transfusion done according to Hb to keep systolic blood pressure (SBP) and/or mean arterial pressure (MAP) above 90 mm Hg and 60 mm Hg respectively. In PA group hemodynamic management was done with CO monitoring. If the CI remained < 2.2 L/m^2/min with dobutamine (initial doses of 5 µg/kg/min), norepinephrine was added (starting dose of 0.02 µg/kg/min, with increments of 0.02 µg/kg/min until the desired MAP level was reached).

In postoperative period if CI < 2.2 L/min/m^2, pulmonary capillary pressure >16 mm Hg, and mixed venous saturation <60% in PA group and high CVP > 12, cold peripheries and central venous saturation <60% in CVP group suggesting patients experiencing (Low cardiac output syndrome (LCOS), dobutamine was started at a dose of 5 µg/kg/min, and if a hemodynamic response was not observed, the dose was increased to 7.5, 10, and finally to 12.5 µg/kg/min at 15 minute intervals. In patients in whom low cardiac output persisted, epinephrine was added as a second inotropic drug at a dose of 0.02 to 0.1 µg/kg/min. Inj. Levosimendan was started in hemodynamically unstable patient in which low cardiac index or cardiac output observed via cardiac output monitoring by PA catheter group and in CVP group it was started when hemodynamics was not maintained with other inotropes or large heart or poor contractility. Inj. milrinone 50 ug/kg bolus followed by infusion at 0.5 ug/kg/min is used if patients showed right ventricular failure in postoperative ECHO.

Criteria for extubation were partial pressure of oxygen PaO_2/FiO_2 more than 250, respiratory rate <25/min, arterial oxygen saturation between 98% and 100% at FiO_2 = 0.4 for 1 hour. Criteria for intensive care unit discharge were spontaneous breathing, hemodynamic stability without inotropic treatment, clear consciousness, and normal renal function.

Both these groups were compared with regards to need for inotropes, fluid challenge, blood and blood product use and postoperative complication. Intensive care unit stay in term of less than 24 hours, between 24 hours and 48 hours, more than 48 hours was observed in postoperative ICU. Any other complication like significant hypotension, arrhythmias, pulmonary complication, renal failure, CNS complication, death was observed.

Statistical analysis

Statistical analysis was performed using SPSS, Version 20.0 (Chicago, IL, USA). Sample size was calculated through http://www.raosoft.com/samplesize.html. Qualitative data were expressed as proportions whereas the quantitative data was expressed as mean ± SD. The chi-squared test and independent sample *t*-test were used to compare categorical and continuous variables respectively. The level of significance was accepted at $p < 0.05$.

Results

There was no significant difference between two groups regarding demographic data including age, weight, height and gender (Table 1).

All patients of both groups were similar in occurrence of left main, number of coronaries block in term of single vessel disease (SVD), double vessel disease (DVD) or triple vessel disease (TVD), ejection fraction, left atrium (LA) size and left ventricle (LV) diameter in both systole and diastole.There

Table 1: Demographic profile of both group

	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
Age	59.23 ± 9.57	57.81 ± 9.50	0.3186
Weight	61.44 ± 9.58	63.8 ± 12.22	0.1520
Height	158.27 ± 8.06	160.17 ± 7.74	0.1085
Gender distribution			
Male	56	63	0.3448
Female	34	27	

were no significant difference between two group in preoperative history of hypertension (HTN), diabetes mellitus (DM), cerebrovascular accident (CVA), recent myocardial infarction (MI) and chronic obstructive pulmonary disease (COPD) (Table 2).

The duration of surgery were 217.05 ± 45.02 min and 222 ± 48.85 in min in PA group and CVP group, respectively, (Table 3) while the numbers of vascular grafts was 3 ± 0.88 and 2.98 ± 0.76 in PA group and CVP group respectively. There were no significant differences between the groups in duration of surgery and number of graft in both groups ($p > 0.05$).

Both groups had similar baseline preoperative HR and MAP. In postoperative period there was increasing trend in HR than baseline HR in both groups. But in PA group HR after grafting were significantly lower than CVP group (p value <0.05) In postoperative period changes in HR in both group swere not significant (p value >0.05) exceptin T18 hr T24 hr and T36 hr (Table 4). There was no significant change in mean arterial pressure

Table 2: Preoperative Cardiac and Co morbid characteristics

	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
ECHO			
LA Size	28.63 ± 3.29	28.52 ± 3.30	0.8216
LV DD	46.04 ± 3.63	46.83 ± 3.38	0.1326
LV DS	29.92 ± 5.35	31.05 ± 5.44	0.1618
EF	47.05 ± 8.27	45.27 ± 6.76	0.1157
Coronary Angiography			
Left Main	37	25	0.0845
TVD	43	57	0.0512
DVD	10	08	0.8038
Comorbid Characteristics			
DM	46	41	0.5508
Recent MI	14	11	06664
COPD/BA	10	13	0.6552
CVA	06	02	0.2779
HTN	54	43	0.1349

LA: Left atrium, LV DD/DS: left ventricular dimensions in diastole (Dd) and systole (Ds), EF: Ejection fraction, TVD: Triple vessel disease, DVD: Double vessel disease, DM: Diabetes Mellitus, MI: Myocardial Infarction, COPD: Chronic Obstructive Pulmonary Disease, CVA: Cerebrovascular accident, HTN: Hypertension

Table 3: Duration of surgery and no. of graft

No. of GRAFT	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
2	16	12	0.5373
3	68	72	0.5907
4	06	04	0.7449
5	00	02	0.4770
Surgery duration	217.05 ± 45.02	222 ± 48.85	0.645

Table 4: Comparisons of Heart rate in both groups

(Heart Rate) HR	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
HR AI	76.51 ± 11.73	71.8 ± 9.79	0.00389
HR BG	76.82 ± 10.51	74.34 ± 9.34	0.0964
HR AG	78.2 ± 10.16	74.64 ± 9.14	0.0146
HR after 1 h	83.65 ± 15.62	82.96 ± 16.94	0.7770
HR after 6 hr	89.38 ± 15.31	85.93 ± 12.79	0.1021
HR after 12 hr	87.71 ± 14.13	85.7 ± 12.18	0.3080
HR after 18 hr	89.52 ± 12.56	85.88 ± 10.95	0.0400
HR after 24 hr	87.21 ± 13.11	82.43 ± 10.60	0.0078
HR after 36 hr	84.23 ± 11.15	80.27 ± 11.31	0.0192
HR after 48 hr	85.13 ± 9.11	82.98 ± 9.97	0.1339

(MAP) In both groups during intraoperative period however in postoperative period at T6 and T12 hours there was higher MAP in PA group than CVP group (p value <0.05) (Table 5).

There was no significant difference of blood lactate level during after induction and before grafting in both groups, but blood lactate level showed increasing trend after grafting in both groups and continued up to 18 hours in postoperative period. AT T12 hours and T18 hours blood lactate level are similar in both groups respectively. After 48 hours blood lactate level was significant lower in PA catheter groups in compare to CVP cathater groups (Table 6).

There was no significant difference of central venous saturation during intraoperative and postoperative periods in both groups (Table 7).

One patients in each group had incidence of IABP insertion because of hemodynamic instability during grafting. There was no need of convert to Cardiopulmonary bypass (CPB) in both groups.

Table 5: Comparison of change of MAP in both groups

Mean arterial Pressure (MAP)	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	p value
MAP AI	84.84 ± 11.81	84.41 ± 12.85	0.8141
MAP BG	88.51 ± 14.45	86.06 ± 12.63	0.2287
MAP AG	85.35 ± 16.03	84.37 ± 12.33	0.6471
MAP after 1 hr	81.65 ± 20.15	86.33 ± 16.91	0.0934
MAP after 6 hr	81.14 ± 13.03	86.94 ± 16.19	0.0088
MAP after 12 hr	79.4 ± 11.50	83.3 ± 13.39	0.0375
MAP after 18 hr	81.17 ± 10.64	83.17 ± 13.32	0.2674
MAP after 24 hr	82.33 ± 12.51	82.25 ± 13.25	0.9677
MAP after 36 hr	79.38 ± 8.34	81.7 ± 11.33	0.1210
MAP after 48 hr	81.6 ± 9.61	81.76 ± 10.93	0.9136

Table 6: Comparison of blood lactate level in both groups

	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	p value
LACTATE AI	2.04 ± 0.52	1.82 ± 0.47	0.0044
LACTATE BG	2.11 ± 0.65	1.91 ± 0.67	0.0465
LACTATE AG	2.03 ± 0.88	2.12 ± 0.94	0.5302
LACTATE after 1 hr	2.13 ± 0.96	2.39 ± 0.76	0.0477
LACTATE after 6 hr	2.91 ± 1.74	2.65 ± 1.29	0.2637
LACTATE after 12 hr	2.77 ± 1.72	2.76 ± 1.41	0.9698
LACTATE after 18 hr	2.90 ± 1.45	2.91 ± 1.20	0.9689
LACTATE after 24 hr	2.92 ± 1.25	2.70 ± 1.19	0.2295
LACTATE after 36 hr	3.03 ± 1.11	2.68 ± 1.02	0.2295
LACTATE after 48 hr	2.85 ± 1.09	2.45 ± 0.77	0.0048

Table 7: Comparison of central venous saturation in both groups

Central venous oxygen saturation	Group 1 Central Venous pressure	Group 2 Pulmonary artery	p value
$ScVO_2$ _AI	71.64 ± 4.27	70.26 ± 4.57	0.0383
$ScVO_2$ _BG	70.04 ± 4.41	69.52 ± 5.02	0.4598
$ScVO_2$ _AG	70.97 ± 4.38	69.27 ± 5.03	0.0167
$ScVO_2$ after 1 hr	71.85 ± 4.12	69.72 ± 4.87	0.0017
$ScVO_2$ after 6 hr	72.14 ± 4.17	70.83 ± 5.57	0.0759
$ScVO_2$ after 12 hr	71.7 ± 6.10	70.31 ± 5.96	0.1243
$ScVO_2$ after 18 hr	70.05 ± 5.44	68.72 ± 5.97	0.1191
$ScVO_2$ after 24 hr	68.71 ± 4.87	68.17 ± 4.70	0.4565
$ScVO_2$ after 36 hr	70.98 ± 4.17	69.66 ± 5.05	0.0574
$ScVO_2$ after 48 hr	71.75 ± 6.40	70.05 ± 7.07	0.0926

There was no significant difference in both groups in terms of intraoperative fluid bolus use, blood, blood products use in both intraoperative and postoperatively. Also there was no significant difference in IV fluid intake and output measured up to 48 hr in postoperative period in ICU (Table 8).

Complications

Incidence of hypotension was higher (31) in PA group in compare to (23) in CVC but failed to reach statistical significance (p value = 0.25). With regards to arrhythmias there were no statistically significant differences in either of the groups (p > 0.05). However, incidence of arrhythmias was 10 and 13 in CVC and PA catheter respectively which was lower side in CVC groups in our study (Table 9).

There was no statistically significant difference in Respiratory, CNS and Renal complication in both groups. (p value >0.05) Although incidence of Renal complication was more in PA (8) group as compared to (2) in CVP groups but it was not statistically significant (p value >0.05). In PA groups no patients had CNS complication in contrast to patients in CVC groups which might be due to more patients in CVC groups having history of CVA (6) as compared to (2) PA groups.

There was no significant difference in mortality in both groups. One patient in each group had mortality in postoperative period.

There was significant difference in noradrenaline use in both groups. In PA groups 56 patients noradrenaline was used in compare to 40 in patients managed with CVC. Use of levosimendan in PA and CVC groups was 13 and 4 respectively. However there was increased use of levosimendan in PA groups but it failed to reach significant level between two groups (p value >0.05) (Table 10).

There was no significant difference in other inotropes like adrenaline, dobutamine and ionodilator like milrinone in both groups.

There was no significant difference in prolonged ICU stays >48 hr in both groups. In CVP catheter group 22 had icu stays less than 24 hr vs 3 in PA

Table 8: Fluid and Blood Product Use

	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
Fluid bolus	32	43	0.1306
BLOOD	49	58	0.2246
POD1 input 24 hr	2046.4 ± 619.4	2148.7 ± 915.6	0.3809
POD2 input 24 hr	2527.7 ± 408.0	2452.8 ± 430.0	0.2319
POD1 output 24 hr	1728.7 ± 632.6	1770.7 ± 817.5	0.7007
POD2 output 24 hr	2141.0 ± 396.7	2098.6 ± 489.1	0.5239

POD-Postoperative Day

Table 9: Comparisons of complications in both groups

Complication	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
Hypotension	23	31	0.2549
Arrhythmia	10	13	0.6552
Respitatiory	04	02	0.6780
Renal	02	08	0.1037
Central Nervous System	04	00	0.1293

Table 10: Inotropes use in both groups

	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	*p* value
Noradrenaline	40	56	0.0250
Adrenaline	07	03	0.3290
Dobutamine	06	12	0.2141
Milrinone	01	00	1.0000
Levosimendan	04	13	0.067

Table 11: Duration of ICU stay

Intensive Care Unit stays	Group 1 Central venous catheter	Group 2 Pulmonary Artery Catheter	P value
ICU <24 hr	22	03	0.0001
ICU 24 to 48 hr	61	77	0.0082
ICU >48 hr	7	10	0.6102

catheter group (p value = 0.001). Discharged time from ICU was between 24 and 48 hr which was statically significant as 77 of patients managed with PA catheter was discharged from ICU in between 24 and 48 hr in contrast to 61 of patients in CVP groups p value (0.008) (Table 11).

Discussion

Routine versus selective use of pulmonary artery catheter (PAC) monitoring in coronary artery bypass grafting operations is a topic of significant debate[8]. Shoemaker, *et al.*[9] werethe first to report on the use of hemodynamic data from PAC to determine fluid therapy and the use of vasoactive drugs. Several studies[8,10] that have evaluated PAC in the setting of CABG surgery have suggested that the benefits of PAC outweigh their risks in patients undergoing major cardiac and vascular surgery. Off pump coronary artery bypass (OPCAB) surgery many times causes hemodynamic instability due to altered positioning of heart, interruption of coronary flow and placement of epicardial stabilizer. So vigilant hemodynamic monitoring is of utmost important during OPCAB surgery. So for this purpose, central venous catheter and pulmonary artery catheter are routinely used. Pulmonary artery pressure (PAP), pulmonary capillary wedge pressure (PCWP) and cardiac output monitoring via thermodilution method are obtained as additional information which helps to optimize patients and decide specific interventions during OPCAB. These parameters cannot be obtained in patients with central venous catheter and their management will only be based on CVP-guided approach in our study. We also measured central venous saturation and serum lactate in arterial blood sample in both groups to determine that whether it helped or not in hemodynamic management in OPCAB.

Many cardiac surgery centers continue to use PACs in a large majority of CABG cases on the basis that placement of a PAC will allow a more complete assessment of hemodynamics and early and more targeted pharmacologic or surgical intervention to restore homeostasis. However, a number of studies refute this and concurrently suggest that PAC use may represent additional unnecessary cost, particularly in low-risk patients with normal LV function. Also, however rare, PAC may have serious associated risks such as pulmonary artery thrombosis or rupture, infection, arrhythmia(s), myocardial or valvular injury, insertion problems, and misinterpretation of PAC data by care providers. Accordingly, whether and when to use PAC in CABG has become a topic of debate.

A study by the Canadian critical care clinical trial group[11] showed no benefit to therapy directed by PAC over standard care in elderly high-risk surgical patients.

This study[12] concluded that the PAC "does not play a major role in influencing outcome after cardiac surgery, that even high-risk cardiac surgical patients may be safely managed without routine PAC, and that delaying PAC until a clinical need develops does not significantly alter outcome, but may have an important impact on cost savings." This trial[12] suffered from lack of true randomization and crossover but remains the only large prospective evaluation of PAC use in patients undergoing coronary artery bypass grafting. Our study also agree with this trial that patient with mild-to-moderate left ventricular systolic dysfunction could be managed with CVP cathater alone but we also observed that routine use of PA cathater in patient with mild-to-moderate left ventricular dysfunction has no harm in terms of postoperative complication and mortality although there was increase duration of ICU hour stays in patients managed with pulmonary catheter (in first 24 hours) that was due to aggressive hemodynamic management with cardiac output monitoring.

A more recent retrospective review (Resano FG *et al.*) of outcomes in low-risk patients undergoing beating heart surgery showed that in the 69% of patients monitored with a PAC versus the 31% with a CVP, there was no change in any outcome variable (e.g., need to convert to bypass or insert balloon pump) including mortality rate. We also observed similar finding as one patient received IABP intra operative in both group in our study. However during surgery there was no need to convert on bypass in any patients in both groups.[10]

It was also suggested that measurement of cardiac output, prompted the frequent use of

inotropic agents to maintain a CI>2 L/min/m^2 in patients managed with PA catheter in contrast to CVP catheter. They also concluded that when confounding variables are controlled, use of a PAC was found to be a significant predictor of use of inotropic support at the end of the surgery. But we found that there was no significant difference in use of inotropes if hemodynamic management was done with PA cathater in off pump CABG. However in our study, we observed that more use of inotropeslike levosimendan in PA groups (13 vs 4) but it failed to reach significant level between two groups (*p* value >0.05). There was no significant difference in routine inotropes and vasopressors in both groups.

A 1989 study by Pearson and associates[7] prospectively randomly assigned 226 elective cardiac operation patients to either CVP, standard PAC, or oximetric PAC monitoring, but 46 of 74 patients randomly assigned to receive CVP had a PAC instead owing to anesthesiologist preference. They also observed no significant differences in mortality and ICU stays among the patient groups like our study. In our study we also observed that there was no significant difference in mortality and prolonged ICU stays >48 hours (*p* value 0.6102) in both groups. However we also found that more patients managed with CVP catheter was discharged earlier from icu stays because we observed significant difference in CVP catheter group 22 vs. 3 of PAC group had icu stays less than 24 hours (*p* value = 0.001). In our study most of patients managed with either PA or CVP catheter, discharge time from ICU was between 24 to 48 hours which was statistically significant as 77 patients managed with PA catheter was discharged from ICU in between 24 to 48 hour in contrast to 61 patients in CVP groups (*p* value 0.008). It was due to more patients discharged earlier in CVP group <24 hr.

We observed that there was no significant difference in postoperative complication like hypotension, renal, CNS, respiratory in both groups. However there was increase rate of CNS complication like stroke and cognitive defect in CVP group (4 vs. 0) compare to PA groups due to previous history of CVA found more in CVP group. Although in our study there was increase trend in hypotension (23 vs 31), arrhythmia (10 vs 14) and renal complication (2 vs 8) in both the groups respectively but it was not statistically significant (*p* value >0.05).

Our finding also supported by Stewart and coworkers[13] whom use six criteria to preoperatively identify 194 of 312 (62%) low-risk CABG patients who would be candidates for CVP as opposed to PAC monitoring. Of these, The CABG proceeded with CVP catheter in 133 patients, whereas there remaining 61 patients had a PAC inserted owing to surgeon or anesthesiologist preference. In these two subgroups, in hospital mortality was similar, although postoperative complications (morbidity) tended to be increased in PAC patients. The choice of monitoring catheter was not randomized in this study as compared to our study so there catheter selection bias might cause observed differences. Therefore, selection bias may have been introduced when the surgeon or the anesthesiologist selected a PA rather than a CVP catheter.

Interesting fact about our study that we also observed relation of serum lactate and central venous saturation because these parameters were very helpful in hemodynamic management particularly in postoperative period. We observed that in serum lactate showed increasing trend in postoperative periods. After 48 hours blood lactate level was significant lower in PA catheter groups in compare to CVC groups. However there was no significant change in central venous saturation during intraoperative and postoperative period in patients managed with either PA or CVP catheter in off pump CABG.

Limitations of our study

Patients with preserved left ventricular function with EF >40% (average) were included for study. These patients can better tolerate hemodynamic alterations during OPCAB than patients with depressed LV function and hence PA catheter might prove beneficial in this category. Further studies are needed to compare hemodynamic management based on either PA catheter or CVP catheter in off pump CABG in patients with compromised left ventricular function.

Conclusion

We can conclude from our study that PAC definitely provides additional information regarding cardiac output and cardiac index which can help for hemodynamic management of patient intraoperatively and postoperative ICU management in comparisons with CVC but clearly it does not result in significant difference in postoperative ICU stay and outcome of patient in form of morbidity and mortality.

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