

Comparative Study of Graft Patency in Off-Pump Vs On-Pump Coronary Artery Bypass Grafting

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ABSTRACT

Objective: To compare number of grafts applied and midterm graft patency in patients undergoing off pump bypass surgery (OPCAB) with conventional on pump coronary artery surgery(C-CABG).

Material & methods: Study was conducted at the Dept. of Cardiac Surgery Punjab Institute of Cardiology Lahore from 1st. June, 2009 to 31st.December, 2009. The study comprised of 100 consecutive patients who underwent CABG. The patients, who were critically ill with hemodynamic instability, had cardiac dysrhythmia or arrest or history of previous cardiac surgery or concomitant cardiac procedures were not included in the study. The patients were randomly divided in two groups by computer generated list using open epi Version 2.0. Group (I) included 47 patients who underwent coronary artery bypass grafting on CPB(C-CABG) and group (II) included 53 patients who underwent Coronary artery bypass grafting without CPB (OPCABG). All patients were operated by the same surgeon. Data was collected and analyzed using SPSS 17.0, Mean±SD is given for quantitative variables. Frequencies and percentages are given for qualitative variables.

Results: All patients included in the study had left internal mammary artery (LIMA)grafted to left anterior descending artery (LAD). Number of grafts applied per patient were 3.0±0.90 in group I and 3.09±0.87 (p=0.67). Male to female ratio in Group I and Group II was 8.40:1 and 7.55:1 respectively. The mean age in Group I was 55.51±8.96 yrs and Group II was 55.57±9.30 yrs. No significant difference was seen in perioperative MI among the groups, Group I ((2.1%) vs. Group II 3(5.66%).

Eighty-nine out of 100 patients under went angiographic study after 6 months to a year. Group I patients had 110 patent grafts out of 134 grafts applied (patency rate of 82.09%) while in Group II 121 out of 154 grafts were found patent (patency rate of 78.5%) with a P value of 0.0634. Over all graft patency for LIMA was 92.12% while for vein grafts it was 74.87%.

Conclusion: OPCAB surgery has no added advantage over CABG done on conventional CPB as regards to early clinical outcome. Comparable graft patency and complete revascularisation can be achieved in OPCAB.

Key words: CABG, Graft patency, off pump, on pump

INTRODUCTION

Off pump coronary artery bypass grafting (OPCAB) is now accepted as an alternative technique to conventional on-pump bypass grafting (C-CABG)¹. A large number of studies have been conducted to compare the clinical outcome in patients undergoing CABG utilising both techniques.

Many clinical trials have reported decreased inflammatory response and myocardial injury by avoiding CPB as indicated by decreased release of myocardial bio markers such as troponin I and MB fraction of Creatinine Kinase (CK-MB). Lesser inflammatory response in OPCAB is shown by minimal alteration in normal levels of biological inflammatory markers like leukocytes, complement factors, interleukins & tissue necrosis factors (TFN)^{2,5}

Large retrospective non randomised trials^{6,7} have shown advantage of OPCAB over C-CABG by demonstrating reduction in operative mortality and major post operative complications which include use of blood products, atrial fibrillation, stroke, pulmonary and renal complications, myocardial infarction and multiple organ failure.

Though the randomised prospective trials⁸⁻¹⁴ have failed to establish a clear cut advantage of OPCAB over C-CABG as regards early important clinical outcomes, still their significant statistical strength has been questioned on the basis of the small number of patients being enrolled in these trials. Still OPCAB has been reported as more beneficial in high risk patients such as women, elderly, patients with atheromatous calcified Aorta, COPD and renal failure. In midterm OPCAB also has been associated with better quality of life as compared to C-CABG.

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Reluctance of the surgeons toward adopting the OPCAB technique is attributed to the concern regarding the quality of anastomosis on a beating heart and inability to graft all vessels, especially those on the lateral and posterior surfaces. This may compromise the long term patency and complete revascularisation¹⁵⁻¹⁹.

Although it has been claimed that the initial problem of anastomosis on a bleeding and moving heart has been overcome by the advent of epicardial stabilisers, intra coronary shunts and coronary blowers, the literature still reports conflicting results regarding graft patency in OPCAB procedures¹¹⁻¹². Due to smaller coronary arteries and the diffuse nature of disease in the Asian population²⁰ graft patency in OPCAB patients becomes even more important. To date no local study is available for graft patency in OPCAB procedure.

Our study is aimed at angiographically comparing graft patency at six months in patients undergoing CABG with or without CPB. After fulfilling the criteria 100 patients were enrolled in the study and then randomised for either OPCAB or C-CABG. Study design was prospective randomised trial. All the information was collected preoperatively, regarding socio-demographic profile of the patients, risk factors for ischemic heart disease, angiographic and echocardiographic findings, per operative details of coronary vessels including size and severity of disease and number of grafts. Post operatively angiographic findings were also entered in the Performa.

MATERIALS AND METHODS

The study was designed as prospective randomised trial. The duration of study was six months i.e. from 1st August to 31st December 2009. One hundred consecutive patients were included in the sample on fulfilling the set criteria. Patients fulfilling the criteria were randomly divided into two groups by computer generated list by using open epi version 2.0. **Group I** included 47 patients who under went CABG on CPB and **Group II** included 53 patients who under went CABG with out CPB. Patients included in this study had, indication for CABG i.e. those patients who had a greater than sixty percent stenosis of the coronary vessels, were haemodynamically stable, and needed isolated coronary artery surgery. Patients having Hemodynamic instability and critically ill patients with concomitant cardiac procedure or previous cardiac surgery were not considered for this study. Those patients having history of prior severe reaction to contrast dye or life threatening anaphylactic reaction were also not included in this group. Patients with history of cardiac arrhythmias or arrest,

Cardiopulmonary collapse or contraindications to CPB and those failing to provide written consent were also excluded.

Statistical Analysis: Data was analysed using SPSS 17.0, Mean±SD is given quantitative variables, frequencies and percentages are given for qualitative variables. Two-independent sample t-test were applied to observe group differences. Paired sample t test was applied to observe pair-wise differences, Pearson Chi square and Fisher exact test were applied to observe associations between qualitative variables. P-value <0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included in this study. The patients were divided into two groups. Group I included 47 randomly selected patients who were operated for coronary artery bypass grafting on CPB, while Group II of 53 patients were operated for coronary artery bypass grafting without CPB. In Group I, 42(89.36%) patients were male and 5(10.63%) were female and in Group II, 46(86.79%) were males and 7(13.20%) were female. There was no significant age difference between the two groups, the mean age in Group I being 55.51 ±8.96 years and in Group II 53.57±9.30 years.

A total of 36 patients were diabetic, 10(21.3%) in Group I and 26 (49.1%) in Group II p=0.0039. Hyperlipidaemia was present in 18(18%) of the patients out of which 11(24.4%) were operated on CPB and 7(13.2%) were in OPCAB group. Fifty-five (55%) were found to be hypertensive, among them 24(51.5%) were in Group I and 31(58.2%) were in Group II. Family history of coronary artery disease was present in 28(28%) patients, of these 13(27.7%) fell in Group I and 15(28.3%) were in group II (p=0.946). Smokers in Group I was 17(36.2%) and in Group II were 15(28.3%). There was no significant difference in ejection fraction (EF) in both groups with the EF in Group I 50±7.70 and in Group II 47.85±9.94. Routine blood tests like Hb%, ESR, Renal Function, Lipid profile, bleeding profile did not show any significant difference in both groups. Per-operative frequency of distribution and number of grafts to different coronary vessels also did not show any significant difference in both groups.

As regards post operative outcomes there was no significant difference in incidence of MI 1(2.1%) in CCABG vs. 3(5.66%) in OPCAB group. Intra Aortic Balloon Pump was not required in any of the patients in Group I and only 1(1.9%) patient in Group II. There was a significant difference in elevation of post operative CK-MB in both groups 151.23±182.56 in

CCABG as compared to 131.21 ± 180.10 in OPCAB ($p=0.036$). Post operative arrhythmias developed in 6 patients (12.67%) Group I and 6 patients (11.32%) in Group II. Four patients (7.6%) had to be converted from OPCAB to conventional CABG.

No neurological injuries were detected in patients done on CPB while 1(1.9%) patient developed neurological symptoms. No significant difference was observed in the amount of bleeding between both groups and two patients in each group had to be reopened for excess bleeding

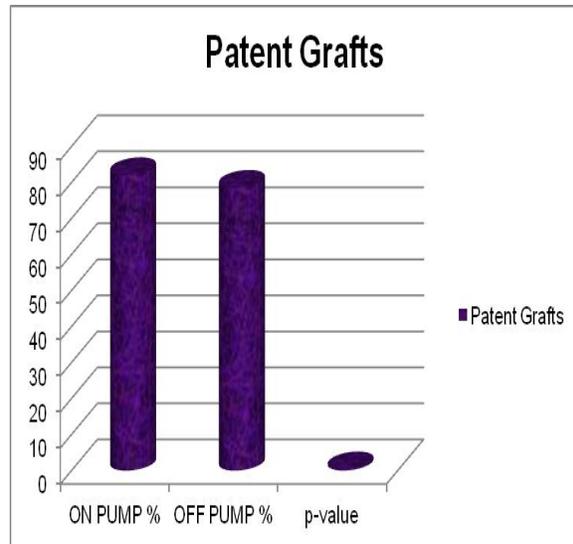
The incidence of pulmonary complications was similar in both groups with 5(10.7%) patients in Group I and 7(13.2%) patients in group II. No significant difference was seen in ventilation time in both groups, 9.22 ± 8.53 hours in CCABG vs. 8.0 ± 5.23 hours in OPCAB.

Although there was an increase in serum creatinine (two times or more than preoperative values) in 4 patients (7.6%) in CCABG and 2 patients (3.77%) in OPCAB group but it was statistically insignificant ($p=0.1731$). None of these patients required dialysis. No patient in the CCABG group developed wound infection as compared to 2(3.77%) patients in OPCAB group. Data regarding ICU stay (4.53 ± 2.15 days in CCABG and 4.17 ± 1.83 days in OPCAB) and hospital stay (12.29 ± 7.11 days in CCABG vs. 13.12 ± 6.01 days in OPCAB) has shown insignificant difference.

At six months to one year, 89 out of the 100 patients included in the study underwent angiography. Eighty-nine out 100 patients under went angiographic study after 6 months to a year. Group I patients had 110 patent grafts out of 134 grafts applied (patency rate of 82.09%) while in Group II 121 out of 154 grafts were found patent (patency rate of 78.5%) with a P value of 0.0634. Over all graft patency for LIMA was 92.12% while for vein grafts it was 74.87 %.

Graft study (n=89)

	On Pump	Off pump
Graft applied	134	154
Patent grafts	110	121



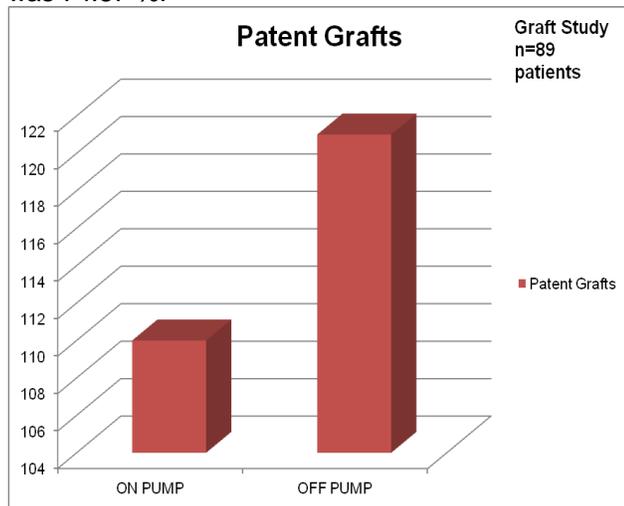
Comparison of Patent Grafts in both groups

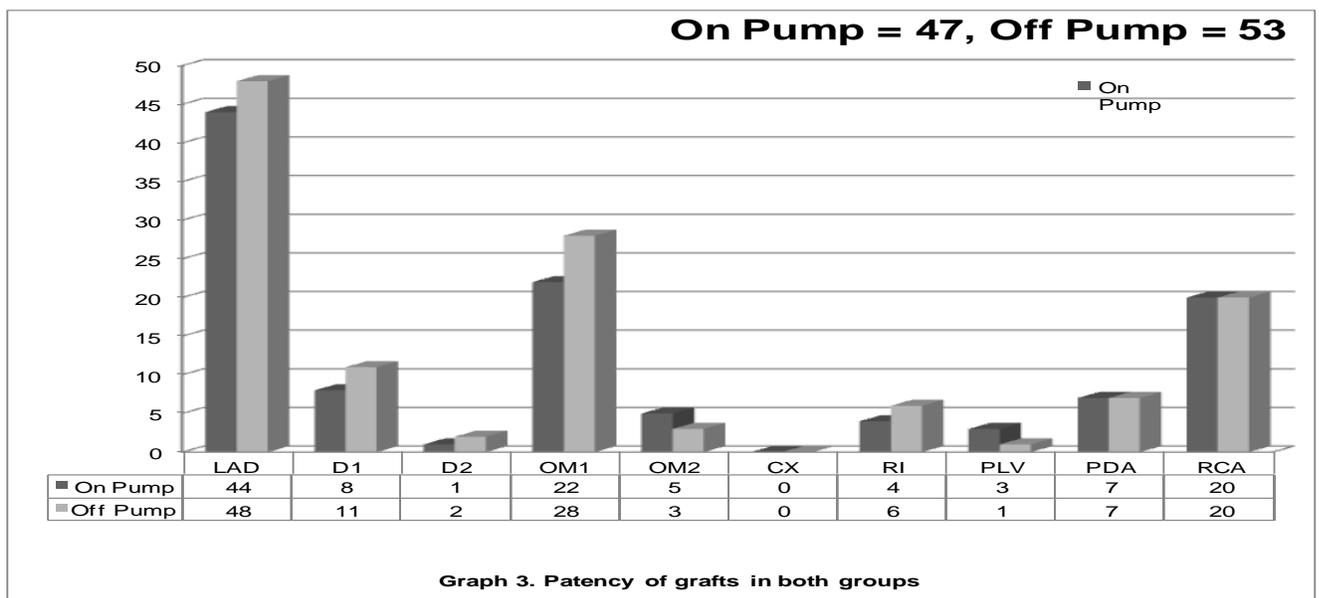
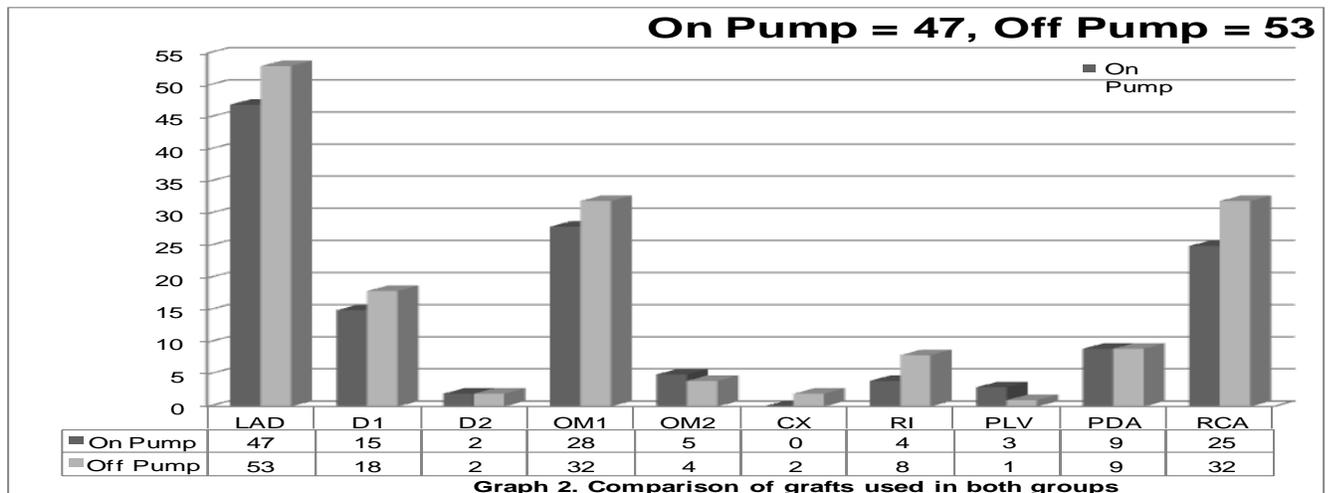
Graft study (n=89)

	On pump %	Off pump %	p-value
Patent grafts	82.09	78.57	0.363

Comparison of graft distribution to different coronary arteries in both groups

	ON-PUMP (%)	OFF-PUMP (%)	p-value
N	43	46	
LAD	43 (100.0)	46 (100.0)
D1	15 (31.9)	18 (34.0)	0.8236
D2	2 (4.3)	2 (3.8)	0.8991
OM1	28(59.6)	32 (60.4)	0.935
OM2	5 (10.6)	4 (7.5)	0.588
CX	0 (0.0)	2 (3.8)
RI	4 (8.5)	8 (15.1)	0.3107
PLV	3 (6.4)	1 (1.9)	0.2526
PDA	9 (19.1)	9 (17.0)	0.7849
RCA	25 (53.2)	32 (60.4)	0.4679





DISCUSSION

This prospective randomised study aimed at comparing graft patency on angiographic findings at six months, in patients undergoing CABG with or without CPB. All the cases were performed by same surgeon who is well trained in both techniques. CABG has been one of the most extensively researched procedures since its introduction in routine clinical practice. In the late 1960s introduction of CPB provided a bloodless and still operative field for the surgeons to construct a coronary anastomosis with precision. Although complete revascularisation with long term graft patency was achieved with this technique, CPB has been recognised as a main cause of complex systemic inflammatory response.

So in order to avoid these complication OPCAB was started early in 1990s by Benneti & Buffalo.

Early large retrospective observational trials clearly favoured the OPCAB.⁶ On the other hand the randomised prospective trials although had shown comparable clinical outcome in OPCAB but failed to prove clear-cut advantage of either procedure on important clinical outcomes⁹.

More over the critics of OPCAB had shown their reservation about the quality and patency of anastomosis in OPCAB. With conventional CABG LIMA graft patency at 15 year is >90% and any new revascularisation method must compete with this gold standard.

Many factors were implicated to be responsible for inferior graft patency in OPCAB. These include a

steep learning curve, distraction caused by cardiac motion and ventilation, construction of anastomosis on a moving target, and anastomosis at less favourable coronary segment. In addition to these technical reasons it has been shown that patients are at the highest risk for the graft occlusion (up to 30%) in the early months after CABG procedure, this has been attributed to increased procoagulant activity after CABG. This state is more pronounced in OPCAB group and the difference in this procoagulant state in OPCAB and C-CABG groups may be responsible for lowering vein graft patency in OPCAB group as reported in a few randomised studies.

Non randomised trials have consistently shown excellent patency rates for OPCAB but majority of the studies were selective requiring only one or two grafts. But the report of inferior graft patency rates in OPCAB in one of the earlier randomised controlled trial by Khan & Colleagues¹¹ cast serious doubts on the quality of anastomosis and opened a new debate on the impact of this new procedure over graft patency. The authors analysed the graft patency in 89 patients (43 patients on OPCAB and 46 on C-CABG), out of 100 patients who were originally enrolled in the study. The remainder were not willing to undergo angiography again. The overall patency rates for graft performed on pump was significantly higher than the patency rate on those performed off pump (98% vs. 88% $p=0.002$). However, the closer analysis of study by Khan & Colleagues¹¹ revealed many factors for poor graft patency in those who underwent off pump surgery. The off pump method is technically more demanding and the surgeon had operated only 98 OPCAB cases before participating in the study. This limited experience coupled with relatively lower doses of intraoperative heparin and the absence of aggressive antiplatelet therapy with clopidogrel postoperatively and failure to use new suction devices to optimize the exposure may have contributed to these results.

Our study had shown insignificant difference in overall graft patency in both groups (82% in CCABG vs 78.5% in OPCAB, $p=0.4964$), which is consistent with other randomised controlled trials conducted worldwide.

Lingaas et al analysed the coronary angiography reports of 115 patients at three months post operatively. Of the 120 patients who were randomised in this trial, no difference was found in overall graft patency (88.5% in OPCAB vs 93.8% in CCABG).

Nathoe also reported similar graft patency in both groups while analysing OCTOPUS trial. But the study has limitations because only 25 percent of patients under went repeat angiography at one

year²⁰. SMART trial was conducted in USA and Puskas et al reported the angiographic results at one year postoperatively in 153 patients and found significant difference in graft patency in both groups .

It is always difficult to graft the coronary arteries on the posterior aspect of the heart. In the earlier studies only those patients were included who needed anterior grafts. Our study also revealed no difference in the number of grafts to the circumflex territory in both groups. Incremental improvements in surgical techniques including routine use of wide bilateral transverse pericardiotomies, multiple pericardial traction sutures and rotation of the heart into the right pleural cavity have recently allowed visualization of the obtuse marginal coronary targets in a high proportion of patients in OPCAB group.

In our study we have also found a lower graft patency in both groups as compared to the above mentioned randomized trials. Relatively small size and diffusely diseased coronary vessels with poor runoff in our population may be a contributing factor. Over the years the spectrum of patients being referred for CABG has changed due to the advance in percutaneous intervention (PCI) techniques and devices. Patients with more diffuse disease and multiple lesions are under going CABG and this has been reflected in decreased vein graft patency rates. Our study has revealed an overall lower vein graft patency in both groups (76.92% in CCABG vs 73.14% in OPCAB). The same finding also has been reported in the PRAGUE-4 trial. This single centre study was had the participation of four surgeons, four hundred patients were randomised either for CCABG or OPCAB. PRAGUE-4 was unique because cardiologists and not the cardiac surgeons chose who was randomised for surgery. One year follow up by angiography was done in 225 patients. The authors concluded that almost all the patients with good quality vessels are treated with PCI and current population of cardiac surgery patients have more advanced coronary artery disease.

The present study has several important limitations. The performance of all cases by the same surgeon reduced surgical variability, thus making both groups more comparable, but the generalisation of finding to other surgeons and health care workers has not been provided. Although early clinical outcomes had been compared which revealed no significant difference in mortality and morbidity in both groups , but midterm follow up parameters such as recurrence of angina, myocardial infarction and other related medical complications requiring hospital admissions and or reinterventions were not studied. So the midterm impact of graft patency on clinical outcome was not evaluated.

CONCLUSION

We conclude that OPCAB has no added advantage over C-CABG as regards to early clinical outcome. Comparable graft patency and complete revascularization can be achieved in OPCAB provided this procedure is carried out by an experienced surgeon. We recommend that junior surgeons should get trained on relatively low risk patients, requiring one or two anterior grafts, under the supervision of senior surgeons so that they may be able to perform this procedure in future on patients having relative contraindications to CPB. Furthermore the future randomised controlled trials should identify groups of patients who will get maximum benefit from OPCAB and help to formulate guide lines for indications for OPCAB.

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