Original Article

Coronary Artery Surgery with or Without Cardiopulmonary Bypass: Impact on Early Outcome

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Abstract: During the last 10-15 years, coronary artery surgery without use of cardiopulmonary bypass has gained popularity. Although worldwide incidence of off-pump surgery has remained around 15%, retrospective studies have shown that off-surgery reduces the inflammatory response, mortality and morbidity associated with coronary artery surgery.

Objective: To compare early postoperative outcome in patients undergoing coronary artery surgery with or without cardiopulmonary bypass.

Methods: A prospective randomized control trial was conducted in Punjab Institute of Cardiology Lahore. Two hundred consecutive patients undergoing coronary artery surgery were randomized in two groups. Group I included 107 patients who underwent coronary artery bypass grafting on CPB and Group II included 93 patients who underwent coronary artery bypass grafting without CPB. Critically ill patients with hemodynamic instability, previous cardiac surgery and patients needing concomitant cardiac procedure were excluded from the study. Incidence of early post operative (within 30 days) mortality and morbidity (myocardial infarction, bleeding, stroke, arrhythmias, renal and pulmonary complications and infection) were compared among two groups.

Results: In group I, 96 (89.71%) patients were male and 11(10.29%) were female. In group II, 81(87.09%) patients were male and 12 (12.91%) were female. There was no significant difference in age, preoperative ejection fraction and risk factors for coronary artery disease between two groups. Routine blood tests including Hb, ESR, LFTs, RFTs, Lipid profile, bleeding profile did not show any significant difference among both groups. There was no significant difference in 30 days mortality among two groups, 2.8% in CCABG as compared to 4.3% in OPCAB (p=0.492). No significant difference in incidence of adverse post operative cardiac outcomes as MI [4 (3.7%) in CCABG vs. 7 (7.5%) in OPCAB], use of intra aortic balloon pump [2(1.9%) in CCABG vs. 2 (2.2%) in OPCAB] and low cardiac output syndrome [2(1.9%) in CCABG vs. 1(1.0%) in OPCAB] was found among two groups. No significant difference was observed in amount of bleeding in both groups. The incidence of pulmonary, renal and neurological complications was similar in both groups. Data regarding ICU stay (5.07+3.88 in CCABG vs. 4.23+2.11 in OPCAB) and hospital stay (12.8+8.14 in CCABG vs. 11.55+5.83 in OPCAB) showed insignificant difference.

Conclusion: Our study has not shown superiority of OPCAB over CCABG with regards to early mortality and morbidity which is consistent with other RCT conducted worldwide. So cautious approach is needed in widespread adoption of OPCAB.

Key Words: Cardiopulmonary bypass, coronary artery disease, coronary angiography

Introduction

Before the advent of cardiopulmonary bypass (CPB) sporadic cases of off pump coronary artery bypass surgery using internal mammary artery or saphenous vein were reported.[1,2] All these procedures were difficult and not reproducible due to moving target and bloody surgical field. Since 1968, use of CPB made CABG easily reproducible. This technique of coronary artery bypass grafting has become conventional (CCABG). Although CPB provides technical ease and precision of anastomosis, blood coming in contact with the plastic and metal components during extra corporeal circulation mediates systemic inflammatory response.[3,4] This inflammatory response along with non pulsatile blood flow and possible embolization of air or debris significantly contributes to renal, pulmonary and neurological complications, excessive bleeding and even multi-organ failure.[5] Variable degree of myocardial damage may occur despite good

in ventilation time (10.91±12.66 in CCABG vs. 8.88±8.66 in OPCAB) was observed in both groups. Although there was increase in serum creatinine two times or more than pre operative value in 10 patients (9.4%) in CCABG and 7 patients (7.5%) in OPCAB group, which is statistically insignificant ($p = 0.631$) but none of them required dialysis.

Two patients (1.9%) developed wound infection in CCABG as compared to four (3.7%) in OPCAB group, which was also statistically insignificant. Data regarding ICU stay (5.07±3.88 in CCABG vs. 4.23±2.11 in OPCAB) and hospital stay (12.8±8.14 in CCABG vs. 11.55±5.83 in OPCAB) stay had shown insignificant difference.

Discussion

Since 1968, almost all the surgical coronary revascularization was being done on CPB. The technical ease provided by CPB made this procedure easily reproducible and this procedure has become conventional method. Although CPB and aortic cross clamping provided bloodless and motionless field for coronary anastomosis, it also contributed to adverse post operative outcomes. So in 1980s surgeons started to perform CABG without pump in order to avoid these complications. Extensive research has been carried out but there is no conclusive evidence to establish the superiority of OPCAB over CCABG with respect to important early and long term clinical outcomes.

The OPCAB surgery provided a great opportunity to establish relative contribution of CPB towards the development of adverse post operative outcomes after CABG. The reduction in inflammatory response and myocardial injury by avoiding CPB and cardioplegic arrest in OPCAB has been addressed by many clinical experimental studies. It has been reported that OPCAB is associated with less myocardial damage when compared with CCABG as indicated by reduction in release of myocardial biomarkers such as Troponin I and Creatinine Kinase (CKMB).[16,17] Postoperatively, inflammatory response is milder in OPCAB as shown by minimal alteration in normal levels of biological inflammatory markers like leukocytes, complement factors, interleukins, and tissue necrosis factor (TNF).[18,19]

The effect of these experimental studies has been analyzed for clinical outcomes in larger retrospective and small prospective randomized trials. No difference in risk adjusted mortality between OPCAB and CCABG was reported by Racz et al. More than 6,800 patients were analyzed retrospectively showing significantly higher rate of strokes (2.0 % vs. 1.6% p=0.003) and re-operation due to excessive bleeding (2.2% vs. 1.6% p<.001) in CCABG group.[20] In another retrospective non-randomized study, Cleveland and colleagues analyzed 1, 18,140 CABG patients as recorded in National Adult Cardiac Surgery Database of the Society of Thoracic Surgeons. 11,717 patients were OPCAB and 106423 operated conventionally. Using risk adjustment analysis, author demonstrated not only significant reduction in operative mortality with OPCAB (2.3% vs. 2.9%, p<.0001) but also lesser major post-operative complications (10.6% vs. 14.1%, p<.0001) which include deep sternal infection, bleeding, renal failure and prolonged ventilation.[11] Calafiore and colleagues also reported similar results.[21]

Mack et al reported significant reduction in mortality rates (1.9% in OPCAB vs. 3.5% in CCABG), in a retrospective analysis of 7,238 patients undergoing OPCAB and 10118 patients undergoing CCABG. Although there were higher percentage of patients with congestive heart failure, COPD, renal failure, stroke, peripheral vascular disease and previous CABG in OPCAB group, still the rate of complications was lower including use of blood products, wound infection, re operation for bleeding, atrial fibrillation, stroke, pulmonary and renal complications, myocardial infarction and multi organ failure. So authors concluded that in addition to less mortality and morbidity, the OPCAB is more beneficial in high risk groups such as women, older adults and patients undergoing re operation.[22]

Angelina and colleagues analyzed the results of Beating Heart Against Cardioplegia Arrest Studies (BHACAS). These prospective studies included 201 patients randomized for CCABG and 200 patients for OPCAB and showed no significant difference in post operative mortality.[23] Van Dijk and colleagues also found no significant difference in early mortality in multi center prospective trial which included 281 patients. These patients were divided randomly in two groups, 139 in OPCAB and 142 in CCABG.[24]

Although retrospective studies have revealed reduced post operative complications in OPCAB group regarding incidence of MI, stroke, reopening for bleeding and acute renal failure, our study has shown no significant difference in these complications between these two groups which is consistent with other prospective randomized trials.[23-26]

Straka et al conducted a trial on 400 consecutive

CCABG, patients were investigated for any of following end points within 30 days; death, stroke, or new renal failure requiring dialysis. The authors reported that there was no significant difference between two groups in post operative mortality, MI, stroke, wound infection, atrial fibrillation, or renal failure.[25]

Puskas and more recently Khan et al, showed no significant difference in post op complications while analyzing 200 & 103 patients respectively in prospective randomized trials.[27,26]

This also holds true for our study which has also demonstrated no significant difference in mortality in both groups. Our study has shown no significant difference in incidence of MI and low cardiac output syndrome requiring intra aortic balloon pump between OPCAB and CCABG groups. Difference in elevation of cardiac enzyme (CKMB) was insignificant in both groups postoperatively, which signifies equally good myocardial preservation.

Gerola et al conducting a multi center randomized study has shown no significant difference in post operative ventilation time and ICU stay.[28] Puskas also found no significant difference in ICU stay among both groups.[26] In our study no statistically significant difference was observed between OPCAB and CCABG groups as regards to ventilation time, intensive care and hospital stay.

The retrospective observational studies have revealed favourable short term impact of OPCAB for important early post operative clinical outcomes such as mortality, myocardial infarction, stroke, renal failure requiring dialysis, while randomized controlled trials (RCT) could prove statistically significant for only two outcomes (atrial fibrillation and red cell transfusion). This observed discrepancy in results between retrospective and RCT can be due to many reasons. Firstly, statistically significant difference in outcome is driven by large sample size in retrospective observational studies. Secondly, the OPCAB patients who were analyzed in retrospective studies were low risk requiring one or two anterior grafts and there might be a failure of risk adjustment technique to match adequately for the difference between patients who underwent OPCAB as compared to CCABG. Thirdly technical expertise might have played part in producing better results in OPCAB in retrospective studies as senior surgeons usually opted for OPCAB while conventional CABG was being operated by all surgeons including residents. Finally conversion from attempted OPCAB to CCABG is associated with increased mortality and morbidity. Up to 13% conversion has been reported in the OPCAB; favourable outcome might be exaggerated if converted procedures are regarded as CCABG in surgical registries.

Conclusion

Our study has not shown superiority of OPCAB over CCABG with regards to early mortality and morbidity which is consistent with other RCT conducted worldwide. So cautious approach is needed in widespread adoption of OPCAB since technically more demanding procedure is offered in place of successful, well defined and reproducible procedure. OPCAB can be offered to patients for surgical revascularization for economical consider-ation provided long term graft patency and period free of re-intervention is comparable with conventional CABG. Furthermore, the future RCT should identify groups of patients who will get maximum benefit in OPCAB and help to formulate guidelines for indications of OPCAB.

We finally conclude that OPCAB has no added advantage over CCABG as regards early important outcome and can be offered to patients for economic consideration.

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