ORIGINAL REPORT

Outcome of Coronary Artery Bypass Grafts: Comparison between on Pump and off Pump

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Abstract- The present study was undertaken to compare the in hospital results of coronary artery bypass graft (CABG) with (on pump) or without (off pump) cardiopulmonary bypass (CPB). Data were collected on all first-time isolated CABGs with saphenous vein and/or artery grafts at Shahid Madani Hospital in Tabriz-Iran, between 2006 and 2009. Age and clinical profile were marched between on pump and off pump group patients. Patients with concomitant cardiac operations or beating pump technique were excluded from the study. The study included 994 patients; CABG with CPB (ONCABG) was done in 578 (58%) and CABG without CPB (OPCABG) in 416 (42%). For pump and off pump group respectively, mortality rate was 2/3%, and 0.2%, the number of grafts was2/92 ± 0.82 and 2/12 ±o.73 and the use of intra aortic balloon-pump (IABP) was1.5% and5.4%. Post operative ejection fraction (EF) was improved in off pump group (47.9±0.6) versus on pump group (44.53±1.5) and the latter group had more post operative atrial fibrillation, Stroke, acute renal failure, bleeding rate and blood products transfusion, prolonged intubation time but was not statistically significance. Meanwhile Hospitalization time and use of inotrops was less in comparison with former patients group. Off pump CABG was a safe method in our series. Patients with comparable risk profiles have similar prevalence's of selected complications after ONCABG and OPCABG, though some clinical and hemodynamic results are better with off pump technique.

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Key words: Coronary artery bypass; cardiopulmonary bypass; stroke volume

Introduction

Coronary artery bypass grafts surgery (CABGs) has been an accepted treatment of coronary artery disease (CAD) (1). The surgery may be performed with cardiopulmonary bypass (CPB), but in this method, circulation is in nonphysiological environment requiring external pump (2). From 1970, CABGs was performed routinely by using CPB (3).

During CPB, physiologic stresses due to passage of blood through non endothelial surfaces within pump, causes the acute excitation of all humeral and cellular processes of inflammation, affecting all organs including the heart and lungs, the kidney, viscera, brain, and also the blood (4-11). Gibbon performed the first successful surgery with CPB in 1953 which had great importance in CPB development as current methods.1 Surgically treatment modalities of CAD include three methods: with CPB(ONCABG) and cardiac arrest (the most common technique), beating heart with CPB (empty beating), and without CPB(OFCABG) (5,6). In the off pump method, a part of the heart is fixed using mechanical instruments such as octopus, and the vascular graft is performed avoiding pump complications including humeral and cellular inflammatory responses of CPB, embolic accidents, metabolic, endocrine and electrolyte changes, lung injury, renal failure, effect on viscera and liver and neuralgic system (12-14).

The purpose of this study was to observe and compare the prevalence of selected in hospital complications (atrial fibrillation, stroke, acute renal failure, prolonged intubation, Gastrointestinal Bleeding, reoperation, and bleeding) between subjects undergoing primary isolated ONCABG or OPCABG at a single center. The cohorts were matched with respect to key risk factors (patient's sex, age, left ventricular ejection fraction (LVEF), hypertension, diabetes mellitus, hyperlipidemia, and smoking) to balance distribution of confounding variables.

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Patients and Methods

Patients

Between 2006 and 2009, 994 patients referred for isolated primary coronary artery bypass grafts, underwent ONCABG or OPCABG at Shahid Madani Hospital in Tabriz-Iran. Patients with CAD and concomitant cardiac surgery, reoperation CABGs, and beating pump bypass grafts were excluded from study. Age and clinical profile, degree of left ventricular ejection fraction were similar between both groups (Table 1).

Data were imported and analysed statistically, using Chi Square and t-test. Our Institutional Ethics Committee approved the study, and waived the need to obtain patient consent.

Surgical technique

Surgical incision was median sternotomy. All on pump group patients were connected to cardiopulmonary bypass with ascending aorta and right atrial cannulation. Patients were either actively cooled or temperature was allowed to drift. Myocardial protection was achieved using cold blood cardioplegia delivered ante grade or retrograde, or both. Off pump CABGs addressed using stabilizer and intra coronary shunt in beating heart manner. Coronary bypass was performed to all major territories as long as there appeared to be viable myocardium and the coronary arteries were not too small or too heavily calcified. Viability studies were performed as needed but not on a routine basis.

Results

The mean ages of on pump and off pump groups' were 57.9±10.2 and 57.5±9.9 respectively. Demographic, clinical and Preoperative echocardiographic data were similar between the two groups, as viewed in Table 1, and Perioperative Surgical data are presented in Table 2 showed that the number of grafts in on pump groups (2.92±0.82) was more than off pump groups (2.12±73) while it was not statistically significant (*P*= 0.55).

Meanwhile the use of left internal mammary artery (LIMA), right internal mammary artery (RIMA), and radial artery in the former were 95%, 6%, and 0.5%, versus 95.5%, 31%, and 8% in latter (*P*= 0.8, 0.19, and 0.86).

Table 1. Comparison data of variables in two groups

Variable	Off pump (without CPB)	On pump (with CPB)	P value
Number	416	578	-
Mean Age (years)	57.5 ± 9.9	57.9 ± 10.2	0.8
Male	307 (74%)	416(77%)	0.6
Hypertension	258 (62%)	421(73%)	0.2
Diabetes mellitus	199 (48%)	323 (56%)	0.4
Hyperlipidemia	258 (62%)	456 (79%)	0.4
Smokers	237 (57%)	335 (58%)	0.9
Obstructive lung disease	50 (12%)	52 (9%)	0.7
Renal failure	95 (23%)	132 (23%)	1.0
Peripheral vascular disease	79 (19%)	98 (17%)	0.7
Stroke	37 (9%)	46 (8%)	0.7
Atrial fibrillation	66 (16%)	69 (12%)	0.8
Previous MI	12 (3%)	14 (2.5%)	0.7
Preoperative LVEF	46.9±0.5	49.5±1.4	0. 4
Elective surgery	269(65%)	432(75%)	0.1

Table 2. Perioperative Surgical Data of two groups

Variable	On pump	Off pump	P Value
Use of mammary artery	95.5%	95%	0.8
Number of bypass grafts	2.92 ± 0.82	2.12 ± 0.73	0.55
Postoperative LVEF	44.53±1.5	47.9±0.6	0.03
Bleeding rate	2.3%	1.7%	0.5
Stay in ICU (days)	3.27 ±2.52	3 ±2.77	0.1
Hospitalisation time (days)	15.71± 6.81	12.34± 6.13	0.001
Use of Inotrops	38.92%	18.75%	0.001
Use of balloon pump	1.5%	5.4%	0.04
Lactate elevation	23.30±1.08	19.30±1.32	0.001
CK-MB level	68.9± 11.1	46.88± 2.84	0.01
ECG changes	14.3%	5.1%	0.01
Transfusion of packed cells (units)	1.95 (2.36)	1.59 (1.90)	0.19

There was more bleeding rate, ICU and hospital stay, use of inotrops and intra aortic balloon pump (IABP), lactate elevation, high CK-MB level, and frequent EKG changes in on pump group than off pump group, although only hospital stay, inotrops, and lactate level reached statistically meaningful. LVEF preserved much better in off pump groups. Overall operative mortality was 2.5%, on pump group 2.3% and off pump 0.2% (*P* = no significant).

The requirement for transfusion of packed red blood cells did not differ significantly between groups (mean (SD), ONCABG 1.95 (2.36) vs. OPCABG 1.59 (1.90) units, *P* = .19). Overall, 27.1% of ONCABG subjects required 3 units or more of packed red blood cells compared with 21.5% of OPCABG subjects (*P* = .34)

Complications

The 2 groups did not differ significantly in overall prevalence of complications. New onset of atrial fibrillation was experienced by 5.5% of ONCABG and 5.1% of OPCABG subjects (*P* = .89). Only small percentages of ONCABG groups had a stroke (0.7%) and acute renal failure (1.6%). Similar percentages of subjects required reoperation (CABG 2.7% vs. OPCABG 1.5%; *P* = .76). The incidence of prolonged intubation in ONCABG was low (8.8%), but higher than OPCABG groups (4.3%) (Table 3).

Discussion

Coronary artery bypass grafting performed on the beating heart date to the early 1960s (2). Some complications of CABG associated with cardiopulmonary bypass has been stabilised, including atrial fibrillation, bleeding, and stroke, are thought to be associated with cardiopulmonary bypass, Consequently, interest has been raised in OPCABG as a means to avoid complications attributed to cardiopulmonary bypass (15,16).

Table 3. Postoperative complications in CABG with and without CPB

Complications	On pump	Off pump
Atrial fibrillation	25(5.5%)	5(5.1%)
Stroke	3(0.7%)	-
Acute renal failure	9(1.6%)	-
Gastrointestinal Bleeding	7(1.3%)	2(1.1%)
Reoperation for bleeding	15(2.7%)	3(1.5%)
Prolonged intubation	45(8.8%)	9(4.3%)
Mortality	2.3%	0.2%

In a retrospective review, Haase et al (17) compared 90 ONCABG and OPCABG patients matched with respect to age (65 vs. 66 years), and sex (62% vs. 73% male), Euro SCORE (3.6 vs. 3.3), graft-patient ratio (2.1 vs. 2.1), and target vessels (80 of the 90 were left anterior descending artery). They reported that a greater percentage of OPCABG patients required perioperative administration of packed red blood cells, although the difference was not significant. Both groups had a similar need for intraoperative and Postoperative administration of platelets, and fresh-frozen plasma. The prevalence's of postoperative atrial fibrillation, stroke, intensive care unite (ICU) and hospital stay, were similar, but a trend toward greater prevalence of return to the operating room for bleeding in ONCABG patients.

Louagie and assosistesl (18) performed a retrospective case-matched study of 90 ONCABG and OPCABG patients, with respect to age, sex, body surface area, number of diseased vessels, and LVEF. Louagie found no difference in the prevalence of postoperative atrial fibrillation or reoperation for bleeding. Although OPCABG patients experienced a shorter ICU stay than did ONCABG patients, hospital stay was nearly equivalent. Stroke prevalence and transfusion requirements were not reported.

Like aforementioned matched-case studies, we found that postoperative atrial fibrillation remains a complication of CABG whether or not cardiopulmonary bypass is applied. Some investigators have hypothesized that inflammatory mediators thought to cause atrial fibrillation would be eliminated if cardiopulmonary bypass were not required. However, Diegeler and coworkersl (19) found that some inflammatory mediators are released during OPCABG, and although the release of immune mediators is enhanced by the use of cardiopulmonary bypass, an inflammatory, as well as an anti-inflammatory, response to surgical trauma occurs regardless of whether cardiopulmonary bypass is used.

Place et al. (20) compared prevalence of atrial fibrillation and time to onset in 199 subjects undergoing ONCABG or OPCABG. The 2 groups had similar prevalence's of atrial fibrillation regardless of procedure (P = .23). Peaked onset of atrial fibrillation was on postoperative day 2 for both groups. Thus, our findings corroborate for the presence of a common, albeit unknown, pathophysiology for postoperative atrial fibrillation that is independent of CPB and its consequences.

Magee et al. (21) conducted by using unmatched groups, reported findings in subjects with higher graft-patient ratios (ONCABG= median 4 grafts and OPCABG= median 3 grafts). The ONCABG patients were more likely than the OPCABG patients to receive packed red blood cells and to require reoperation for bleeding, but the 2 groups had similar prevalence's of stroke. They did report a selection bias for fewer grafts per OPCABG subject.

In a different study, Puskas et al. (22) examined subject groups with closer similarity in the graft-patient ratios. They compared the outcomes of 98 unmatched subjects undergoing primary isolated OPCABG with 99 CABG patients. The groups were similar with respect to prevalence of atrial fibrillation and stroke. Cumulative transfusion of packed red blood cells from surgery to postoperative day 3 (OPCABG (0.77) vs. CABG (1.79) units, P=0. 01) was significantly different but clinically similar (mean difference 0.2 units).

This study indicated equilibrium between administration of packed red blood cells in the ONCABG (mean 1.95 units) and OPCABG (mean 1.59 units) groups. Some of these differences in blood product administration may be related to local practices and transfusion thresholds, and thus make it difficult to interpret significance from both a statistical and a clinical standpoint. The prevalence of ischemic stroke was low in our study (0.7%). Like other matched-case studies, 17 it was not statistically significance.

We found significant between-group differences in hospitalisation time (but not ICU time). Jarvinen et al. (23) noted a significantly longer postoperative stay for ONCABG subjects, and Lee et al tavafian@modares.ac.ir24 found a significant difference in total hospital stay for OPCABG and CABG patients but did not report if some of these days preceded surgery. This study emphasised other researchers finding that compared ONCABG patients with OPCABG patients, required less administration of vasoactive drugs, 17,25 had less release of myocardial enzymes, and lactate elevations (22). It should be mentioned that, our study was conducted in a single academic teaching institution with multiple surgeons who had various levels of experience with the OPCABG procedure. Some evidence indicates that both short-and long-term outcomes can be correlated to the experience and skill of the individualsurgeon (21, 22, 26). In conclusion, our findings suggest that, ONCABG and OPCABG patients matched with respect to risk factors experience a similar prevalence of selected complications although some clinical and hemodynamic results are better with off pump technique. So OPCABG is recommended as an alternative surgical modality treatment for ONCABG in coronary disease patients.

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