Bahrain Medical Bulletin, Vol. 31, No. 3, September 2009

Outcomes of Off-pump Coronary Artery Bypass Surgery

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Background: Off-pump coronary artery bypass surgery is gaining more popularity worldwide. The theoretical and proven disadvantages of the use of the cardiopulmonary bypass for multi-vessel coronary artery bypass grafting has prompted many cardiac surgeons in the world to convert to Off-pump coronary artery bypass.

Objective: To assess the early outcomes of patients who underwent off-pump coronary artery bypass surgery.

Setting: Queen Alia Heart Institute.

Design: Retrospective study.

Method: Seventy-two patients, 54 were males and 18 were females, they underwent Off-pump coronary artery bypass grafting from January 2006 to December 2008. The age ranged 42-79 year, the mean age was 58.5 years. Analysis of in-hospital mortality, perioperative and postoperative courses and outcomes were performed.

Result: Average number of grafts per patient was 2.6, 54 (75%), patients were extubated within the first 6 hours after surgery and 20 (27.78%) patients received blood transfusion. Seven (9.72%) patients had atrial fibrillation, 2 (2.78%) patients had Q wave myocardial infarction, one of them died. One (1.39%) patient had stroke, 2 (2.78%) patients had acute renal impairment, and one (1.39%) patient had deep sternal wound infection.

Conclusion: Off-pump coronary artery bypass grafting seems to be a safe procedure and have reasonable early outcomes.

Bahrain Med Bull 2009; 31(3):

Direct coronary revascularization on the beating heart was first performed by Kolessor in 1967[1]. After 1968, Coronary Artery Bypass Grafting (CABG) with Cardiopulmonary Bypass (CBP) was widely adopted, since it provides a motionless and bloodless field,

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which allows surgeons to construct an optimal anastomosis on the diseased coronary artery[2]. However, CPB has been recognized as a potentially avoidable hazard[3]. Therefore, Off-Pump Coronary Artery Bypass (OPCAB) continued to be performed by many surgeons, consequently beating heart surgery is not a revolutionary new approach[4].

Cardiopulmonary Bypass and cardioplegia have been the main stays of coronary artery bypass grafting for along time; however, CBP has been recognized as one of the major causes of postoperative complications and multiple organ failure, especially in the elderly patients or in the presence of diffuse atherosclerotic disease[5].

During the past few years, the development of technology for OPCAB has led to the resurgence of interest in beating heart surgery, in the hope of improving outcomes and lowering costs, especially in high risk patients[6,7]. Proponents have continued to examine the efficacy of OPCAB procedures in comparison with conventional CABG with CPB, but controversy exists on the selection of patients who are most likely to benefit from the procedure and on the claims of improved outcomes[8].

Due to the great improvement in technology which resulted into an optimal operative field, the ability to perform coronary anastomosis on the beating heart has increased; many authors have shown that even patients with multivessel coronary artery disease can be successfully revascularized with the use of off-pump techniques; therefore, OPCAB has become a real alternative[9,10].

The aim of this study is to assess the early outcomes of patients who underwent off-pump coronary artery bypass surgery.

METHOD

The medical records of 72 patients who underwent OPCAB from January 2006 to December 2008 were reviewed. The choice for Off-pump was determined by the surgeon after it has been agreed to it by the patient. All the data regarding morbidity and mortality were collected retrospectively.

The following risk factors and patients data were recorded: age, sex, hypertension, diabetes mellitus (DM), Canadian Cardiovascular Society (CCS) classifications of functional limitation due to angina, New York Heart Association (NYHA) classification of functional limitation due to heart disease, previous sternotomy, angiographic data of diseased coronary arteries and status of the left ventricular function, intraoperative inotropic support, type of grafts used and the coronary targets revascularized. Patients with preoperative creatinine level more than 2mg/dl were excluded from the study to identify those with de novo renal dysfunction following OPCAB surgery.

Early outcomes that were addressed are: early extubation, blood loss and blood transfusion, Atrial Fibrillation (AF), Acute Renal Failure (ARF), characterized by

creatinine rise > 2 mg/dl postoperatively, sternal wound infection, strokes, Myocardial Infarction (MI) and 30 days postoperative mortality.

Surgical Technique

All patients were operated through a standard median sternotomy incision. The conduits were used are: Left Internal Mammary Artery (LIMA), Right Internal Mammary Artery (RIMA), radial artery and great saphenous vein. The internal mammary harvest was performed under direct vision. Saphenous vein harvest was performed by an open technique. The radial artery harvest was performed from the non-dominant forearm after Allen's test. Heparin 1 mg/kg was given before the distal division of the internal mammary artery with supplemental doses to maintain heparinization and reversed with protamine sulfate in 1:1 ratio after the completion of the last proximal anastomosis. Low molecular weight heparin was administered on the second day of the surgery, 1 mg/kg in two divided doses till the patient is fully mobilized.

To stabilize the coronary targets on a beating heart, a special device called Octopus 2 (Medtronic Inc, Minneapolis, MN) was used, and pericardial traction sutures were used to position the heart in an appropriate position. The target coronary artery was snared temporarily; proximally and distally using 4-0 polyprolene sutures with pledgets. Little displacement of the heart was needed to expose the Left Anterior Descending (LAD), diagonal and proximal right coronary arteries. However, exposure of the circumflex branches and the Posterior Descending Artery demanded a combination of maneuvers such as tilting and rotating of the operating table, opening of the right pleura and sometimes giving beta blockers to induce a controlled bradycardia, which were, in away, facilitating distal anastomosis on the beating heart.

Distal anastomoses were accomplished using continuous 7-0 polyproline sutures. A partial occluding clamp was applied over the proximal ascending aorta, and the proximal anastomoses were performed using continuous 5-0 polyproline sutures. All patients were transferred to the Cardiac Intensive Care Unit (CICU). Early extubation was the aim whenever appropriate.

RESULT

During 3 year period, 72 patients, 54 were males, 18 were females had OPCAB. The Mean age was 58.5 years; the range was 43-79. Patients were distributed according to many variables, 22 (30.56) with CCS class III/IV, 8 (11.11%) with NYHA class III/IV. Fourteen (19.44%) suffered previous myocardial infarction during 6 months before surgery, 61 (84.72%) had hypertension, 26 (36.11%) had DM and 54 (75%) were smokers, see Table 1.

Angiographic data, see Table 2, showed that 48 (66.67%) had LVEF > 50%, 6 (8.33%) had LVEF < 30%, and 18 (25%) had LVEF between 30%-50%. Twenty-six (36.11%)

patients had single vessel disease, 28 (38.89%) had double vessel disease, 12 (16.67%) had triple vessel disease and 6 (8.33%) had left main coronary artery disease.

Hundred and eighty-nine bypass grafts were performed (table III), the average number of grafts per patient was 2.6, 33 (45.83%) had complete revascularization as recommended by the cardiologist, 9 (12.5%) needed inotropic support.

Two had (2.78%) postoperative myocardial infarctions; one of them died (table IV). Seven (9.72%) patients had developed transient AF postoperatively, 2 (2.78%) developed postoperative ARF; one (1.39%) had deep sternal wound infection. Fifty-four (75%) patients were extubated in the first 6 hours following surgery, only 20 (27.78%) needed blood transfusion, 3 (4.17%) were taken back to the operating theater to control bleeding, one (1.39%) suffered an ischemic stroke. Postoperative follow-up period was one month.

Table 1: Preoperative Patient Characteristics

Variable	Number and percentage
Age (Years)	
Mean	58.5
Range	42-79
Sex(No.)	
Male	54 (75%)
Female	18 (25%)
Previous MI < 6 months	14 (19.44%)
CCS class III or IV	22 (30.56%)
NYHA class III or IV	8 (11.11%)
Hypertension	61 (84.72%)
DM	26 (36.11%)
Smoking	54 (75%)
Previous sternotomy	5 (6.94%)

MI=Myocardial Infarction, CCS=Canadian Cardiovascular Society classifications of functional limitation related to angina, NYHA=New York Heart Association, DM=Diabetes Mellitus

Table 2: Angiographic Data

Variable	Number and percentage
LVEF	
>50%	48 (66.67%)
30% - 50%	18 (25%)
<30%	6 (8.33%)
SVD	26 (36.11%)
DVD	28 (38.89%)
TVD	12 (16.67%)
Left main stem disease	6 (8.33%)

LVEF=Left Ventricular Ejection Fraction, SVD=Single Vessel Disease, DVD=Double Vessel Disease, TVD=Triple Vessel Disease

Table 3: Intraoperative Data

Variable	Number and percentage
Vascular conduits used	
LIMA	58 (80.56%)
RIMA	4 (5.56%)
Radial artery	9 (12.5%)
SVG graft	64 (88.89%)
Inotropic support	9 (12.5%)
Complete revascularization	33 (45.83%)

LIMA=Left Internal Mammary Artery, RIMA=Right Internal Mammary Artery, SVG= Saphenous Vein Graft

Table 4: Early Postoperative Outcomes

Variable	Number and percentage
Extubation in less than 6 hours	54 (75%)
Patients needed blood transfusion	20 (27.78%)
Reopening for bleeding	3 (4.16%)
Atrial fibrillation	7 (9.72%)
30-day mortality	1 (1.39%)
MI	2 (2.78%)
ARF	2 (1.39%
Average blood loss (ml)	410 (180-720ml)
In-hospital stay period (days)	4.5 (3-11 days)
CICU stay period (hours)	18 (12-32 hours)

ARF=Acute Renal Failure, MI=Myocardial Infarction

DISCUSSION

Off-pump myocardial revascularization, which avoids blood trauma, possible embolization of air or debris, particularly embolization of atherosclerotic debris from the aorta, systemic inflammatory responses and non-pulsatile flow and myocardial injury is gaining popularity as a feasible alternative to conventional CABG with CPB; it is revealing a trend toward lower rates of morbidity and mortality[11,12].

Since most strokes are believed to result from atheroemboli, avoidance of aortic cannulation, aortic clamping and cardiopulmonary bypass should reduce the risk of perioperative stroke[8]. Although most reported studies of OPCAB have been unable to show a reduction in perioperative stroke, several studies have provided evidence of stroke reduction with OPCAB[13-16]. Stamou had demonstrated, by propensity analysis, that on-pump patients were 1.8 times more at risk than off-pump patients[17]. Patel, using multivariate analysis, identified CPB as a risk factor for perioperative stroke[18].

In this study, one (1.39%) patient had stroke, probably he had preoperative chronic AF, risk attributed to his age, having atheromatous ascending aorta and two proximal anastomoses were performed with partial ascending aortic clamping. The adoption of aortic "No Touch" technique, which avoids intraoperative atheromatous embolization from the atherosclerotic aorta into the cerebral circulation, may improve neurological outcomes after OPCAB[19].

Proponents of OPCAB have examined the impact of this surgery on perioperative morbidity, length of CICU and hospital stays. We noticed that the average stay of our patients in CICU is 18 hours, the range is 12-32 hours, and the mean in-hospital stay was 4.5 days, the range is 3-11 days (table IV). Three large meta-analysis studies have reported that the duration of in-hospital stay is substantially reduced in patients who undergo OPCAB[20-22]. Because of the increasing numbers of coronary artery operations being performed, efficient use of hospital resources becomes even more important and OPCAB surgery has been clearly shown to have cost benefits due mainly to a decreased length of stay in the CICU and an overall decrease in in-hospital stay[23].

Reduced use of blood and its products postoperatively in patients, who underwent OPCAB, may be translated into a better outcome[24]. However, the risk of disease transmission and inflammatory reactions, which may adversely affect the recovery and hospital stay, should be considered[25].

Seven (9.72%) patients developed transient AF postoperatively; two of them were in chronic preoperative AF. AF is one of the most common adverse outcomes of CABG surgery, occurs in 20-40% of patients who had CABG with CPB; it is associated with higher risk of cerebrovascular accidents, and preventing AF has been shown to reduce postoperative stroke occurrence[26].

There is no uniting mechanism explaining AF associated with CABG surgery, rather a complex interplay of several related factors. In a randomized controlled trial, Scione et al showed that CBP with cardioplegia is the main independent predictor of postoperative AF for patients undergoing coronary revascularization, since ischemia with OPCAB is regional, whereas in CABG with CPB it is usually global, which may have a detrimental effect on the atrial myocardium resulting in the generation of arrhythmias[27]. During OPCAB surgery, there is less manipulation of the right atrium, as there is no need to insert a cannula. Finally, the inflammatory response, which occurs with cardiopulmonary bypass, may result in lung and renal injuries with the resulting disturbances of acid-base balance and electrolytes may produce atrial irritability leading to atrial fibrillation[28].

Two (2.78%) patients developed ARF, it is less than the incidence of ARF in CABG with CPB surgery, where it varies from 2%-31%[29-31]. Postoperative ARF increases early mortality by 7%-38%[32]. The renoprotective action of OPCAB is most likely due to avoidance of non-pulsatile flow, renal hypoperfusion and hypothermia during the CPB, which may have adverse effects on renal function[33].

One (1.39%) patient had deep sternal wound infection, which was treated by debridement and rewiring, and this low percentage was explained by the lower surgical trauma to the skin, soft tissues and bone.

Two patients had Q wave MI, one of them was fatal, and the other one was managed by inotropes and intra aortic balloon pump, and required stent placement in the obtuse marginal artery. Previous researchers had focused on the lesser degree of myocardial injury after OPCAB versus CABG with CPB, specifically the Creatine Kinase MB (CK-MB) isoenzyme, which was lower in OPCAB patients, suggesting that OPCAB may cause less myocardial damage as compared to CABG with CAB[34,35]. In a prospective randomized study, Khan et al demonstrated that OPCAB was associated with lower myocardial damage as compared to CABG with CAB; however, the graft patency rate was lower at three months in the OPCAB group than to in the CABG with CAB group and the authors raised concerns with respect to the long-term outcome of OPCAB[36].

CONCLUSION

In this study, the average number of grafts per patient was 2.6. Patients were extubated within the first 6 hours after surgery and 28% patients received blood transfusion. Seven patients had atrial fibrillation. Two patients had Q wave myocardial infarction, one of them died.

There has been rebirth of the OPCAB during the last decade, and the advantages associated with the use of this technique are repeatedly emphasized. Due to the innovative technical developments, OPCAB can now be safely offered to patients with multivessel coronary artery disease. It must be emphasized; however, that despite early reports of good results, long-term studies are needed to encourage the use of this technique.

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