The THAI Journal of SURGERY 2014;35:6-10.
Official Publication of the Royal College of Surgeons of Thailand

Original Article

Preliminary Report of Off-Pump Coronary Artery Bypass Grafting (OPCABG) at Lampang Hospital

Nuttapon Arayawudhikul MD
Boonsap Sakboon MD
Jareon Cheewinmetasiri MD
Angsu Chartirungsun MD
Benjamaporn Sripisuttrakul RN
Roungtiva Muenpa BPharm, MPharm, BCP, PhD
Cardiovascular and Thoracic Unit, Department of Surgery, Lampang Hospital, Lampang, Thailand

Abstract

Objective: **Conventional coronary artery bypass grafting (CABG) is the standard treatment for patients with coronary artery heart disease. However, its major and life threatening complications include stroke and renal dysfunction. Off-pump coronary bypass grafting (OPCABG), by avoiding cardiopulmonary bypass, may reduce these complications.**

Patients and Methods: **We retrospectively reviewed the records of 125 consecutive patients (male 59 cases, female 66 cases) who underwent elective OPCABG from April 2011 through September 2013.The mean age (sd) was 63.8 ± 8.6 years. Left main disease was present in 24.8%. Preoperative renal insufficiency (Cr > 2.5 mg/dl) was seen in 20% of cases while previous stroke was found in 2.4%. Mean Euroscore (sd) was 6.65 ± 2.9.**

Results: **Mean graft per patient (sd) was 3.4 ± 1.1. The internal mammary artery was used in 84.8% of cases. Endarterectomy was performed in 11 patients (9.1%). Total arterial grafting was performed in 20 patients (16.0%). Conversion to on-pump technique occurred in 2 cases (1.6%); 2 patients died within 30 days (1.6%); and late deaths occurred in 4 cases (3.2%). Renal dysfunction requiring dialysis occurred in 1 (0.79%), and re-exploration for bleeding occurred in 2 cases (1.6%). There were no stroke events and no sternal wound infections. The mean follow-up time (sd) was 16.4 ± 11.03 months.**

Conclusions: **Early results of OPCABG at Lampang hospital were promising, with no mortality and low morbidity.**

Keywords: **myocardial revascularization, coronary artery bypass grafting, off-pump coronary artery bypass grafting**

Introduction

The history of coronary artery bypass graft surgery (CABG) in Thailand began in 1974, when it was first introduced by Professor Prinya Sakiyalak at Siriraj Hospital. He performed two saphenous vein graft anastomoses to left anterior descending (LAD) and right circumflex arteries (RCA). In 1975, Dr. Chalit Cheanvechai who was practicing at the Cleveland Clinic, came back temporarily to Thailand and operated on the first case of CABG at Chulalongkorn Hospital. However, the number of patients with ischemic heart disease requiring surgery was rather low. The period

Correspondence address: *Nuttapon Arayawudhikul, MD, Cardiovascular and Thoracic Unit, Department of Surgery, Lampang Hospital, 280 Paholyotin Road, Tambon Huawiang, Muang, Lampang 52000, Thailand; Telephon: +668 4606 5546; Fax: +66 5423 7400; E-mail: anuttapon@yahoo.com*

between 1994 and 2003 saw rapid development of advanced new technology; with digitized catheterization laboratories and good quality vascular stents, and the number of percutaneous coronary interventions (PCI) increased. Newer cardiac surgical techniques such as off-pump coronary bypass grafting (OPCABG) were also introduced. During that time, CABG became well established in Thailand and eventually OPCABG was done in 17% of all CABG cases[1].

In 2011, the first National Adult Cardiac Surgical Database Report under The Society of Thoracic Surgeons of Thailand revealed that there was a relative decrease in OPCABG performed during 2006 to 2008, down to about 7% to 9%[2]. Groups performing OPCABG routinely, such as those at the Bangkok Heart Hospital, claimed that there were real benefits such as lower mortality and morbidity, less blood transfusion, less inotropic requirements, reduced myocardial injury, faster recovery, shorter hospital stay, and lower costs[3]. We have known for a while, for example, that cardiopulmonary bypass induced whole-body inflammatory response, which causes increased mortality and morbidity[4], in addition to the traumatic effects of cannulations and subsequent thromboembolism. Neurological trauma may be as high as 2.7% to 3.1%[5].

In Thailand, it was reported that in-hospital crude ratio of mortality for off-pump to that of on-pump was 0.69 (2.4% /3.5%), with average post-operative stroke incidence of 1.1% and new onset renal failure requiring dialysis occurring in 2%, which were rather low rates of occurrence. After a period of preparation, we began offering OPCABG in late 2011. The purpose of the present study was to review our early experience with OPCABG, with special reference to complications such as renal dysfunction requiring dialysis and new onset of stroke, as well as length of hospital stay and hospital mortality.

Material and Methods

From July 2011 to September 2013, our unit performed OPCABG in 125 patients, with 4 cases requiring pump-assisting techniques due to

Table 1 Preoperative patient characteristics

Characteristics	Summary (n = 125)
Age, years: mean±SD	63.8 ± 8.6
Age > 70 years: number (%)	34 (27.2)
Female: number (%)	66 (52.8)
Vessels involved: number (%)	
One-vessel disease	4 (3.3)
Two-vessel disease	7 (16.3)
Three-vessel disease	107 (93.9)
Left-main disease	31 (24.8)
CCS angina class: mean±SD	2.9 ± 0.7
NYHA class: mean±SD	2.6 ± 0.6
Previous myocardial infarction: number (%)	119 (95.2)
Ejection fraction (EF): number (%)	
EF > 50%	82 (65.6)
EF 30% to 50%	34 (27.2)
EF < 30%	9 (7.2)
Peripheral vascular disease: number (%)	4 (3.2)
Hypertension: number (%)	116 (92.8)
Chronic obstructive pulmonary disease: number (%)	19 (15.2)
Diabetes mellitus: number (%)	55 (44.0)
Dyslipidemia: number (%)	107 (85.6)
Renal dysfunction (Cr > 2.5 mg%): number (%)	25 (20.0)
Prior TIA or stroke: number (%)	3 (2.4)
Preoperative intra-aortic balloon pump: number (%)	35 (28.0)
Euroscore 2: mean ± SD	6.7 ± 2.9

SD = standard deviation; CCS = Canadian Cardiovascular Society Criteria; NYHA = New York Heart Association Classification; Cr = Creatinine; TIA =Transient Ischemic Attack

hemodynamic instability. The preoperative characteristics of patients are listed in Table 1.

Details of our standard perioperative and operative procedures were as follows: Informed consent was obtained from all patients, after a briefing about the operation and watching a demonstration video. Angiograms were reviewed at least the day before surgery. Aspirin was usually continued to the day of surgery, while Clopidogrel was stopped at least five days prior to surgery. Anaesthesiologists visited the patient and ordered premedication treatment. A perfusionist was always present in the operating room. Central venous catheter was always placed, and electrocardiography as well as arterial pressure were monitored. Swan-Ganz catheters were not used routinely.

After median sternotomy was made, the conduits were harvested. When finished, heparin 100 IU/kg was administered. The activated clotting time (ACT) was maintained at a level of at least 300 seconds. At the end of operation, protamine was given at a dose of 1 mg/kg to counteract the heparin effect. Patients were placed in the Trendelenberg position or turned towards the surgeon and given volume replacement, with or without inotrope support according to anaesthesiologists.

The pericardium was opened downward from innominate vein along the course of left anterior descending artery, two heavy silk sutures were placed on the left side of the pericardium one centimeter above the phrenic nerve, two deep pericardial traction sutures (LIMA-Stitch) were placed near the left inferior pulmonary vein and between it and inferior vena cava to help facilitate exposure of each segment of coronary territories. Coronary artery stabilization was accomplished by using a commercially available stabilization system, the Octopus™ (Medtronic, Minneapolis, MN). Intraluminal coronary shunts were inserted whenever possible, or 4/0 polypropylene suture occlusions in figure of 8 formation were used as proximal and distal controls to keep the operating field bloodless. CO blower was used in every case. Ventricular pacing was used in cases of bradycardia. Distal anastomoses were performed using a continuous running 7/0 monofilament suture for venous and radial grafts, while 8/0 sutures were used for internal mammary artery (IMA) to left anterior descending (LAD) artery anastomosis. Proximal anastomoses were constructed using 6/0 running sutures, after aortic side clamping.

Preoperative intra-aortic balloon pump was liberally used the night prior to surgery in patients with left main disease and severe left ventricular dysfunction. According to the principle of functional revascularization, the anterior wall was bypassed first with IMA to LAD, then the right coronary artery, and finally the obtuse marginal vessels.

All data were collected retrospectively from computerized database. Patients were followed up at two weeks after surgery, then one month, and every four months thereafter. The data were analyzed using Stata version 11 statistical software (StataCorp, TX, USA).

Results

We have performed OPCABG in 125 cases, with 2 (1.6%) of these converted to on-pump beating heart due to hemodynamic instability (large hearts and low ejection fractions). The number of grafts used varied from 1 to 7, with an average of 3.4 grafts per patient. Left internal mammary artery (LIMA) was used in 84.8% of cases. The mean intubation and operative time was 180 minutes (Table 2).

There was no operative mortality. Thirty-day hospital death occurred in two patients (a hospital mortality of 1.6%). In one patient, death occurred on postoperative day two, from refractory ventricular tachycardia and cardiac arrest in the ICU, developing into multiple organ failure. Another patient died from renal failure and multi-organ failure after endovascular repair (EVAR).

Postoperative mortality and morbidity are shown in Table 3. No stroke was observed and only two

Table 2 Intraoperative findings

Conduits:	
Left internal mammary artery (%)	84.8
Right internal mammary artery (%)	16.8
Gastroepiploic artery (%)	4.8
Radial artery (%)	13.6
Saphenous vein (%)	84.0
Total number of anastomoses	427
Anastomoses per patient: mean±SD	3.4±1.1
Operative time (minutes): mean±SD	198.8±31.3
Conversion to on-pump beating heart: number (%)	2 (1.6)
Total arterial revascularization: number (%)	20 (16.0)

Table 3 Postoperative results of off-pump coronary artery bypass

Variable	Summary
30-day mortality: number (%)	2 (1.6)
Late mortality: number (%)	4 (3.2)
Low cardiac output syndrome: number (%)	16 (13.3)
Re-operation for bleeding: number (%)	2 (1.6)
New onset atrial fibrillation: number (%)	17 (13.6)
New onset stroke: number (%)	0
Renal failure requiring dialysis: number (%)	2 (1.6)
Deep sternal wound infection: number (%)	0
Ventilator time (hours): mean±SD	13.1±4.1
Postoperative of hospital stay (days): mean±SD	6.3±4.4
Total length of hospital stay (days): mean±SD	8.9±5.1

patients required temporary hemodialysis. New postoperative atrial fibrillation was found in 13.6% of patients. The mean intubation time was 13.1 hours. Mean postoperative stay and total length of hospital stay were 6.3 days and 8.9 days respectively. Resternotomy to stop bleeding was done in 2 patients (1.6%).

All patients were followed until September 2013. The mean follow up time was 18.5 months. The Kaplan-Meier estimate of overall survival is shown in Figure 1. There were four late deaths, including two patients who died from COPD with acute exacerbation, developing into hospital-acquired pneumonia about three months after operation. A third patient died at home six months after operation without autopsy; she had poor ventricular function preoperatively and chronic aortic dissection type B. The last patient passed away at home three months after operation, also without autopsy.

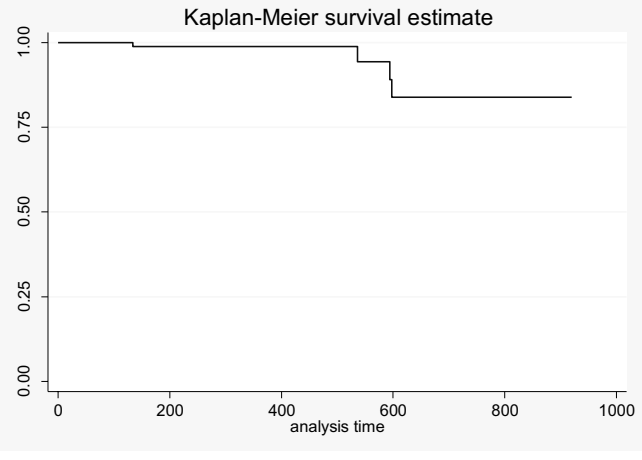

Figure 1 Kaplan-Meier estimate of overall survival in OPCABG patients in the present study

Discussion

Conventional coronary artery bypass grafting is a standard procedure for the treatment of coronary artery heart disease in patients all over the world, including Thailand[6-8]. At Lampang Hospital, we have adopted the OPCABG technique in order to avoid the morbidity and mortality associated with cardiopulmonary bypass (CPB), which can lead to severe systemic inflammatory response especially in high-risk patients[9-12]. Numerous studies have demonstrated the safety and effectiveness of OPCABG, with favorable early outcomes. A recent meta-analysis has revealed that OPCABG may be a safer alternative to conventional CABG with respect to mortality, and it is recommended for reducing perioperative morbidity[13-15].

Details of the OPCABG procedure are constantly developing, including the introduction of innovative techniques such as cardiac stabilizers, cell-savers, and intra-coronary shunts used to create a bloodless field. Better intraoperative coordination between anesthesiologists and surgeons, along with improved cardiac and physiologic monitoring, have resulted in excellent performance of anastomoses in multi-vessel disease, without the use of CPB[16].

In the present study, perioperative morbidity was relatively low in terms of myocardial infarction (0.8%), resternotomy to stop bleeding (1.2%), and no deep sternal wound infection. Our results were similar to those found in the literature[17,18]. We had no occurrence of stroke. Almost all authors agree that patients receiving the OPCABG procedure are less likely to develop a stroke in comparison with conventional CABG, and the incidence of stroke remains low even in high-risk patients[19,20]. We routinely looked for aortic calcification usually visible from chest x-rays, and we used intraoperative transesophageal echocardiography to help evaluate atheroma or aortic calcification, and if these are seen, we used the no-touch aorta technique (total arterial revascularization).

We usually perform complete myocardial revascularization, with a mean number of distal anastomoses per patient of 3.4, which was higher than that of off-pump patients (2.8) and equivalent to that

of on-pump cases (3.5) in the series of Sabik and associates[21]. Kleisli and colleagues[22] demonstrated that the 5-year survival rate of complete revascularization was superior to that of incomplete revascularization (82.4% versus 52.6%).

Conclusion

Our early experience with OPCABG at Lampang Hospital was encouraging in all respects. We had low morbidity rates with no occurrence of stroke and no hospital mortality. However, because the present study demonstrated only the early results of treatment, midterm and long-term results have yet to be evaluated.

REFERENCES

1. Chaiseri P. Development of coronary artery bypass graft (CABG) in Thailand. Thai J Surg 2010;31:39-42.
2. The First National Adult Cardiac Surgical Database Report. The Society of Thoracic Surgeons of Thailand, 2011.
3. Ruengsakulrach P. Off-pump all arterial coronary artery bypass grafting. Bangkok Med J 2011; :32-47.
4. Kirklin JK, Westby S, Blackstone EH, Kirklin JW, Chenoweth DE, Pacifico AD. Complements and the damaging effect of cardiopulmonary bypass. J Thorac Cardiovasc Surg 1983:86:845-57
5. Engelman DT, Cohn LH, Rizzo RJ. Incidence and predictors of TIAs and strokes following coronary artery bypass grafting: report and collective review. Heart Surg Forum 1999;2:242-5.
6. Lytle BW, Loop FD, Cosgrove DM, Ratliff NB, Easley K, Taylor PC. Long-term (5-12 years) serial studies of internal mammary artery and saphenous vein coronary bypass grafts. J Thorac Cardiovasc Surg 1985;89:248-58.
7. Fitzgibbon GM, Kafka HP, Leach AJ, Keon WJ, Hooper GD, Burton JR. Coronary bypass graft fate and patient outcome: angiographic follow-up of 5,065 grafts related to survival and reoperation in 1,388 patients during 25 years. J Am Coll Cardiol 1996;28:616-26.
8. Chaiyaroj S, Viengteeravat S, Bhumarangura W, Khajarern S, Leelayana P, Puruntrapiban B. Techniques and results of off-pump coronary artery bypass grafting using homemade intracoronary shunt. J Med Assoc Thai 2006;89:
9. Larmann J, Theilmeier G. Inflammatory response to cardiac surgery: cardiopulmonary bypass versus non-cardiopulmonary bypass surgery. Best Pract Res Clin Anesthesiol 2004; 18:425-38.
10. Carrico CJ, The elusive pathophysiology of the multiple organ failure syndrome. Ann Surg 1993;218:109-10.
11. Beal AL, Cerra FB. Multiple organ failure syndrome in the 1990s. Systemic inflammatory response and organ dysfunction. JAMA 1994;271:226-33.
12. Arom KV, Flavin TF, Emery RW, Kshettry VR, Petersen RJ, Janey PA. Is low ejection fraction safe for off-pump coronary bypass operation? Ann Thorac Surg 2000;70:1021-5.
13. Immaki M, Ishida A, Shimura H, et al. Early results of off-pump coronary artery bypass. Jap J Thoracic Cardiovasc Surg 2005;53:244-50.
14. Hirose H, Amano A, Yoshida S, Takahashi A, Nakano N. Off-pump coronary artery bypass: early results. Ann Thorac Cardiovasc Surg 2000;6:110-
15. Puskas J, Cheng D, Knight J, et al. Off-pump versus conventional coronary artery bypass grafting: a meta-analysis and consensus statement from The 2004 ISMICS Consensus Conference. Innovations 2005;1:3-27.
16. Shennib H, Lee AG, Akin J. Safe and effective method of stabilization for coronary artery bypass grafting on beating heart. Ann Thorac Surg 1997;63:998-92.
17. Cheng DC, Bainbridge D, Martin JE, Novick RJ. Does off-pump coronary artery bypass reduce mortality, morbidity, and resource utilization when compared with conventional coronary artery bypass? A meta-analysis of randomized trials. Evidence-Based Perioperative Clinical Outcomes Research Group. Anesthesiology 2005;102:188-203.
18. Ascione R, Reeves BC, Rees K, Angelini GD. Effectiveness of coronary artery bypass grafting with or without cardiopulmonary bypass in overweight patients. Circulation 2002; 106:1764-70.
19. Calafiore AM, Di Mauro M, Contini M, et al. Myocardial revascularization with and without cardiopulmonary bypass in multivessel disease: impact of the strategy on early outcome. Ann Thorac Surg 2001;72:456-62.
20. Demaria RG, Carrier M, Fortier S, et al. Reduced mortality and strokes with off-pump coronary bypass grafting surgery in octogenarians. Circulation 2002;106: I5-I10.
21. Sabik JF, Gillinov AM, Blackstone EH, et al. Does off-pump coronary surgery reduce morbidity and mortality? J Thorac Cardiovasc Surg 2002;124:698-707.
22. Kleisli T, Cheng W, Jacobs MJ, et al. In the current era, complete revascularization improves survival after coronary artery bypass surgery. J Thorac Cardiovasc Surg 2005; 129:1283-91.