Off-Pump Coronary Bypass Surgery and All Arterial Conduits : Learning Experience at Bangkok Heart Institute

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Abstract

Off-pump coronary artery bypass technique or bypass graft surgery without the use of a heart-lung machine has been introduced in the last six years, and now comprises approximately 25 per cent of all coronary artery bypass surgery being done in the world. One of the goals of beating heart surgery is to eliminate the complications associated with the use of cardiopulmonary bypass. The use of all arterial conduits for coronary artery bypass graft has become more acceptable after experiences gained and reports of better long-term results.

From January 2001 to December 21 2002 the authors performed 251 off-pump procedures. One hundred and nine of these cases were done utilizing all arterial conduits

The data was stratified using the US National Society of Thoracic Surgeons Cardiac Surgery Database pre-operative risk module and divided into 3 groups as suggested: Low risk group with a predicted mortality of 0-1 per cent (2 patients); Medium risk group with a predicted mortality of 2-9 per cent (87 patients), and High risk group with a predicted mortality of 10+ per cent (10 patients). The predicted mortality of the entire group was 4.5 per cent.

There were 90 males and 19 females with a mean age of 60.2 $\pm$ 10.7 years, with 15.6 per cent of them older than 70 years. Pre-operative co-morbidities included $^1/_4$ of the patients who had ejection fraction (EF) of equal to or less than 0.4, 4.5 per cent had unstable angina, 1.6 per cent had urgent/ emergent status, 26.6 per cent underwent re-operative procedure, 1 per cent had pre-operative serum creatinine more than 2 mg per cent, 4.8 per cent had a history of stroke, 20.2 per cent had a history of congestive heart failure, 45.2 per cent had a history of previous myocardial infarction, 10.7 per cent had a history of chronic obstructive pulmonary disease, 46.9 per cent had a history of diabetes, 62 per cent had hypertension, and 20 patients (18.3%) required intra aortic balloon pump.

Intra-operative parameters revealed 3.7 $\pm$ 1.3 grafts/patient. The left internal mammary artery (LIMA) was used to the left anterior descending (LAD) in 6.4 per cent, or sequential with the diagonals 93.6 per cent. The 30 days mortality was 3.6 per cent (4 cases). Further analysis revealed that pre-operatively, none of these 4 cases was in the low predicted (predicted mortality of 0-1%) risk group, 2 of them were in the medium (predicted mortality of 2-9%) and the other 2 were in the high predicted risk (predicted mortality of 10+%) group. The skin-to-skin time was 4.1 hours and there were two conversions to on-pump in this group.

Post-operatively, the intubation time was 4.7 hours. There was no peri-operative myocardial infarction, one patient required dialysis, and no patient experienced stroke. There was no sternal wound or arm wound infection, 9.5 per cent experienced temporal sensation impairment at the site of the radial artery harvesting at one month. Re-operation for bleeding occurred in 3 cases, and thirteen patients (14.3%) developed new atrial fibrillation.

The authors are no longer making a one-foot long incision and spread ten inches wide like in the old days'. With the less invasive approach lessened in the recent past, the authors have found the less invasive the incision the less the pain after surgery. Totally eliminating the leg incision has allowed the patient to get up and mobilize on the same afternoon, if the procedure was done in the morning. All of these approaches combined with the off-pump technique, as far as the authors are concerned, will provide those who need coronary arterial bypass graft the best operative procedure.

Key word : Off-Pump CABG

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Off-pump coronary artery bypass technique or bypass graft surgery without the use of a heart-lung machine has been introduced in the last six years, and now comprises approximately 25 per cent of all coronary artery bypass surgery being done in the world. One of the goals of beating heart surgery is to eliminate the complications associated with the use of cardiopulmonary bypass.

Although large randomized studies do not yet exist to validate whether in fact the mortality and morbidity are decreased; there is a preponderance of evidence that at least some complications associated with coronary bypass surgery (CABG) are decreased with elimination of cardiopulmonary bypass while other complications and mortality appear to have a minimal decrease or to be unchanged(1,2).

The use of all arterial conduits for CABG has become more acceptable after experiences gained and reports of better long-term results. Arterial conduits are the first choice in multiple CABG for all patients, particular the young because they offer well known, longer patency rates than the vein grafts(3). In coronary artery bypass grafting, selection of the conduits is varied because most patients require multiple coronary revascularizations. The left internal mammary artery (LIMA) is the first choice of conduit for left anterior descending (LAD) revascularization. The next choices for arterial conduits are free radial artery (RA) and the right internal mammary artery (RIMA). The gastroepiploic artery (GEA) is used mainly to the branches of the right system. Without using the vein in the leg, the incision and the related post-operative incision pain are eliminated. This incision pain from the leg, in many occasions, is more severe than the pain from sternotomy.

Since the use of all arterial conduits and off-pump CABG are of interest to the patients and referring physicians, the combination of the two approaches could provide the best immediate and long-term outcomes to the patients. This interest lead the authors to review the recent published articles and our own experiences of this subject during the past 2 years.

MATERIAL AND METHOD

Off-pump program at the Bangkok Heart Institute started in January of 2001. At that time one surgeon was fully trained and had done, since 1996, approximately one thousand off-pump procedures,

at one of the pioneer institution in United States. The authors started this program very slowly and cautiously at Bangkok Hospital. An anesthesiologist was locally trained and sent abroad for further experience. There are now a total of three well-trained anesthesiologists ready for this procedure. At the present time, three cardiac surgeons have been trained and able to perform this type of surgery with ease. Two more surgeons are being trained at the moment. All the physicians are not only trained for the changes in the operating room practice, but also for the post-operative care, which is also somewhat different from on-pump surgery. The authors strongly believe that only dedicated and well trained anesthesiologists and cardiac surgeons who believe in the procedure will able to carry out the procedure with excellent outcomes.

From January 2001 to December 21, 2002 the authors performed 251 off-pump procedures. One hundred and nine of these cases were done utilizing all arterial conduits. The data of this group of patients were collected while the patients were still in the hospital and at the 30 days' follow-up. All pre-operative demographics and co-morbidities, intra-operative parameters and post-operative outcomes up to 30 days were recorded. Only important and appropriated variables were analyzed. Chi-square test was used to compare clinical, intra-operative and post-operative variables between patients. All statistical tests were two tailed, with statistical significance defined as $p < 0.05$.

The data was stratified using the National STS Cardiac Surgery Database pre-operative risk module and divided into 3 groups as suggested: Low risk group with a predicted mortality of 0-1 per cent (2 patients); Medium risk group with a predicted mortality of 2-9 per cent (87 patients), and High risk group with a predicted mortality of 10 per cent and up (10 patients). The predicted mortality of the entire group was 4.5 per cent.

The cases were all done by different surgeons in the group. There was no pre-selection according to the severity, co-morbidity or status of the patients. Early on, each of the off-pump cases was done according to the surgeon's preference, but after December 2001 every CABG case at Bangkok Heart Institution was scheduled as an off-pump approach, even with the high risk patients, such as ejection fraction of less than 10 per cent or having 2 plus ischemic mitral regurgitation.

RESULTS

There were 90 males and 19 females with a mean age of 60.2 ± 10.7 years, with 15.6 per cent of them older than 70 years. Pre-operative co-morbidities included $^1/_4$ of the patients who had ejection fraction of equal to or less than 0.4, forty-seven per cent of the patients had significant left main diseases, 4.5 per cent had unstable angina, 1.6 per cent had urgent/emergent status, 26.6 per cent underwent re-operative procedure, 1 per cent had pre-operative serum creatinine more than 2 mg per cent, 4.8 per cent had a history of stroke, 20.2 per cent had a history of congestive heart failure, 45.2 per cent had a history of previous myocardial infarction, 10.7 per cent had a history of chronic obstructive pulmonary disease, 46.9 per cent had a history of diabetes, 62 per cent had hypertension, and 20 patients (18.3%) required intra aortic balloon pump.

Intra-operative parameters revealed 3.7 ± 1.3 grafts/patient. The LIMA was used to the LAD in 6.4 per cent, or sequential with the diagonals 93.6 per cent, the radial artery was connected to the ascending aorta either with aortic connector or usual sewing technique in 99 per cent of the cases. This artery was anastomosed to the intermediate artery and/or to the fist obtuse marginal, the second obtuse marginal, the third obtuse marginal and distal circumflex/postero-lateral branches of the right coronary artery (RCA) respectively, on side to side and end to side fashion respectively in 96 cases (88%). The RIMA was used to RCA in 8 cases (7.3%) and the right radial artery was used in only 2.7 per cent of the cases. The 30 days mortality was 3.6 per cent (4 cases). Further analysis revealed that pre-operatively, none of these 4 cases was in the low predicted (predicted mortality of 0-1%) risk group, 2 of them were in the medium (predicted mortality of 2-9%) and the other 2 were in the high predicted risk (predicted mortality of 10+%) group. The skin-to-skin time was 4.1 hours and there were two conversions to on-pump in this group.

Post-operatively, the intubation time was 4.7 hours. There was no peri-operative myocardial infarction (POMI), one patient required dialysis, and no patient experienced stroke. There was no sternal wound or arm wound infection, 9.5 per cent experienced temporal sensation impairment at the site of the radial artery harvesting at one month. Re-operation for bleeding occurred in 3 cases, and thirteen patients (14.3%) developed new atrial fibrillation.

DISCUSSION

From the previous published reports and from the present review it is obvious that the off-pump surgery offers better outcomes than the on-pump procedure in spite of the lack of a large number of randomized trials available at the present time[1,2]. The accumulative data from the National Society of Thoracic Surgeons Cardiac Surgery Database showed a significant difference, statistic wise, of the outcomes in all categories[4]. But in clinical practice, the differences of the comparable outcomes are so small; therefore, the difference in the outcome remains debatable.

An overall mortality benefit has not yet been clearly demonstrated; but undoubtedly the benefit from the off-pump procedure in high-risk patients is real[1]. The patients who most benefit from off-pump techniques are not the patients at which the surgeon's skill is at a learning curve, but with surgeons who are already trained and are comfortable with off-pump techniques under optimal circumstances. The authors feel that the maximization of benefits and minimization of complications of beating heart surgery is best achieved by:

- Committed surgeons
- Attention to detail "it is the little things that make the difference"
- Avoidance of over-reaction of the team
- Experienced, committed and limited number of anesthesiologists
- Optimal composition and committed to "the team"
- A consistent first surgical assistant
- Critical care pathway nurses

Post-operative complications that require different management due to off-pump techniques include pain management. Since patients are usually extubated immediately, more aggressive early pain management including epidural analgesia, local analgesia and intravenous anti-inflammatory agents are helpful. The patients should receive maximal pain management for early ambulation and breathing exercises, in order to minimize pulmonary complications and shorten their recovery. It is amazing to see, on several occasions, that these patients are sitting up and having supper on the same afternoon of surgery.

The authors are no longer make a one-foot long incision and spread ten inches wide like in the old days'. With the less invasive approach lessened in the recent past, the authors have found the less invasive the incision the least the pain after surgery. Totally eliminating the leg incision has allowed the patient to get up and mobilize on the same afternoon, if the procedure was done in the morning. The authors also no longer use a long incision for the radial artery harvesting. Instead, a 3 cm long skip incision was made and the radial artery was taken out with a Harmonic scalpel. This was designed to minimize the post-operative discomfort.

All of these approaches combined with the off-pump technique, as far as the authors are concerned, will provide those who need CABG the best operative procedure.

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การผ่าตัดต่อเส้นเลือดหัวใจโดยไม่ใช้เครื่องปอดหัวใจเทียม

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การใช้เส้นเลือดแดง (All arterial conduit) ในการทำผ่าตัดบายพาสของหัวใจและการทำผ่าตัดหัวใจโดยไม่ต้องใช้เครื่องปอดหัวใจเทียม (Off-pump CABG) เป็นที่สนใจเป็นอย่างมากของแพทย์และคนไข้ในปัจจุบันนี้ ทั้งนี้เพราะการใช้ 2 วิธีนี้ร่วมกันอาจจะให้ผลดีที่สุดในระยะยาวของคนไข้ จากเหตุผลนี้ทำให้เราทบทวนเอกสารต่าง ๆ เกี่ยวกับเรื่องทั้ง 2 นี้ พร้อมกับ retrospective review การทำผ่าตัดแบบนี้ที่โรงพยาบาลกรุงเทพเมื่อสองปีที่ผ่านมา

การผ่าตัดแบบ Off-pump ได้เริ่มใช้อย่างจริงจังที่ศูนย์หัวใจ โรงพยาบาลกรุงเทพเมื่อมกราคม 2544 ในขณะนั้นมีศัลยแพทย์ 1 คนซึ่งได้รับการอบรมจากต่างประเทศ และได้ผ่านการทำผ่าตัดแบบนี้มาพอสมควร และได้สร้างทีม Off-pump ขึ้น และขณะนี้มีศัลยแพทย์ 4 คน และวิสัญญีแพทย์ 3 คน ซึ่งสามารถทำการผ่าตัดแบบนี้ได้อย่างดี พร้อมกันนี้กำลังฝึกอบรมให้กับศัลยแพทย์อีก 2 คน และวิสัญญีอีก 1 คน ซึ่งคาดว่าจะสามารถทำการผ่าตัดแบบนี้ได้ในอีกไม่ช้า

ตั้งแต่ 1 มกราคม 2544 ถึง 21 ธันวาคม 2545 เราได้ทำ Off-pump surgery ไป 251 ราย ใน 109 รายนี้ใช้ All arterial conduit ข้อมูลของคนไข้เก็บในขณะที่คนไข้อยู่ในโรงพยาบาลและ follow-up เมื่อครบ 30 วัน การวิเคราะห์ข้อมูลนี้ใช้ National STS Cardiac Surgery Database Pre-operative risk module และแบ่งผู้ป่วยออกเป็น 3 กลุ่ม คือ Low risk group มี predicted mortality 0-1% (คนไข้ 2 คน), Medium risk group มี predicted mortality 2-9% (คนไข้ 87 คน) และ High Risk Group มี predicted mortality 10% ขึ้นไป (คนไข้ 10 คน), overall predicted mortality เท่ากับ 4.5%

ผลการรักษา มีคนไข้ชาย 90 คน คนไข้หญิง 19 คน อายุเฉลี่ย 60.2 ปี, 15% ของคนไข้อายุมากกว่า 70 ปี, ประมาณ 1 ใน 4 ของคนไข้มี ejection fraction เท่ากับหรือน้อยกว่า 0.4, 47% คนไข้มี left main disease, 4.5% มี unstable angina, 1.6% เป็น urgent/emergent status, 26% เป็นการผ่าตัดครั้งที่สอง, 1% มีไตพิการโดยที่มี serum creatinine มากกว่า 2 มิลลิกรัม, 4.8% มีประวัติของ stroke, 20% มีประวัติของ heart failure, 45% มีประวัติของกล้ามเนื้อหัวใจตายมาก่อน, 10% มีประวัติของ COPD, 46% มีประวัติเป็นเบาหวาน, 62% มีความดันสูง และ 18% ต้องใช้เครื่องปอดหัวใจเทียม

จำนวน graft เท่ากับ 3.7 $\pm$ 1.3 ต่อคนไข้, LIMA ใช้ใน 6.4% ถ้ารวมกับ Sequential to diagonal เท่ากับ 94%, Radial artery ใช้ 99% ของ case, RIMA ใช้ไปต่อที่ RCA 7.3%, Right radial artery เพียง 2% และ GEA 38% อัตราตายภายใน 30 วัน 3.6% หรือ 4 ราย

เมื่อพิจารณาให้ละเอียดพบว่าในกลุ่ม low risk ไม่มีคนไข้เสียชีวิต, คนไข้กลุ่ม medium risk จะเสีย ชีวิต 2 คน และคนไข้กลุ่ม high risk เสียชีวิต 2 คน ใช้เวลาผ่าตัดจาก skin to skin 4.1 ชั่วโมง ไม่มี Peri-operative MI, คนไข้ 1 คน ต้องทำ dialysis, ไม่มีคนไข้ที่เป็น stroke หลังผ่าตัด, 3% คนไข้ต้องทำการผ่าตัดใหม่ เนื่องจากมีเลือดออกมากกว่าปกติ, 14% มี new Artial fibrillation

จากการ review articles พบว่า Off-pump surgery ให้ผลที่ดีกว่า On-pump surgery ถึงแม้ว่าจะไม่มีการ randomized trial ก็ตาม ข้อมูลจาก National STS Cardiac Surgery Database พบว่าการทำ Off-pump มีผลแทรกซ้อนและอัตราตายของคนไข้น้อยกว่า On-pump นอกจากนั้นแล้วมีหลายบทความที่ยืนยันว่า Off-pump surgery มีผลดีมากในผู้ป่วยที่มี pre-operative co-morbidity สูง

คำสำคัญ : ผ่าตัดหัวใจไม่ใช้ปอด-หัวใจเทียม

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