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Off-Pump Coronary Artery Bypass Grafting Surgery in Early Stage Myocardial Infarction Treatment

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ABSTRACT

We evaluated the surgical results of off-pump coronary artery bypass grafting (OPCAB) performed within the first 12 h of infarction in patients with acute myocardial infarction. From January 2005 to January 2007, emergency coronary artery bypass grafting without cardiopulmonary bypass was performed in 56 patients with acute coronary syndromes. The mean age was 62.9 (range, 51-86) years. All patients underwent OPCAB via sternotomy.

An average of 2.5 ± 1.1 grafts per patient were performed. The mortality rate was 7.1% (4 of 56 patients). One patient suffered from postoperative stroke (1.7%), and 3 (5.3%) needed hemofiltration for acute renal failure. Postsurgery elective coronary angiography (n = 21) showed no significant stenosis. These results indicate that emergency OPCAB can be applied to patients with acute myocardial infarction with low morbidity and mortality and excellent early results.

INTRODUCTION

Cardiac surgeries to treat patients suffering acute myocardial infarction (AMI) are being performed more frequently and with less mortality and morbidity. Because of conditions such as reduced cardiac function, performance of surgery in emergency situations, or the presence of comorbidities, cardiac surgery in AMI patients should be kept as minimally invasive as possible. According to the literature, the risk of adverse side effects of coronary artery bypass grafting (CABG) is higher in AMI patients [Wan 1997]. Systemic inflammatory response syndrome (SIRS) during and after cardiac surgery is primarily related to cardiopulmonary bypass (CPB) [Wan 1997]. CABG without the use of CPB has been shown to reduce SIRS [Wan 1997; Ascione 2000]. Off-pump CABG (OPCABG) is gaining widespread acceptance as the preferred choice for myocardial revascularization in patients with AMI [Rastan 2006]. OPCABG is a form of open-heart surgery in which clogged arteries are bypassed while the heart is still beating. OPCABG eliminates the use of CPB and cardioplegia and thus should bring about significant decreases in postoperative morbidity and mortality compared to conventional CABG. Many clinical studies have, to various extents, established the effectiveness of OPCAB [Vlassov 2001]. Patients undergoing OPCABG have benefited in ways that include shorter postoperative hospital stay, fewer pulmonary complications, less need for blood transfusion [Wan 1997; Ascione 2000; Rastan 2006], fewer postoperative cardiac arrhythmias, and decreased incidence of intra- or postoperative MI or neurological dysfunction [Chen-Scarabelli 2002; Sabik 2002]. It has been established that some of these differences in outcomes are significant in specific subgroups of patients classified according to their preoperative risk assessment [Riha 2002; Yokoyama 2000].

We report the results of OPCAB performed in patients with AMI, which carries significant risk.

METHODS

The diagnosis of AMI was established by the presence of continuous chest pain and changes in the conventional electrocardiogram and enzyme criteria (creatine kinase–myocardial band more than twice the normal value of <11 IU/L). The presence of an occluded vessel was confirmed by coronary angiography. The most commonly used graft was the left internal mammary artery (LIMA). We used the saphenous vein graft less frequently. We did not use radial artery grafts because of the emergency situation and high age group of the patients.

PATIENTS

We studied 56 AMI patients treated at our institute from January 2005 to January 2007 who had emergency indications according to the current guidelines [Eagle 2004] and who underwent emergency OPCABG within 12 hours after admission to the coronary care unit. All patients who met these criteria underwent OPCABG. There were 43 male and 13 female patients. The mean age was 62.9 (range, 51-86) years. Twenty-eight patients (50%) had diabetes, 3 of whom were insulin dependent; 45 (80.3%) had hypertension; 9 (16.1%)

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had test results indicating impaired renal function (serum creatinine >3 mg/dL); and 7 (12.5%) had a history of cerebrovascular accident. Intraaortic balloon pumping was previously used in 12 patients (21.4%). Three patients were under respiratory support. Four patients (7.1%) had suffered cardiogenic shock (systolic blood pressure <80 mm Hg; cardiac index<1.8 L/m^2), necessitating aggressive inotropic support and intraaortic balloon pumping. Of the patients included in the study: 33 (58.9%) had anterior, 20 (35.7%) had inferior, 2 (3.5%) had non-Q MI, and 1 (1.7%) had true posterior infarcts.

Preoperative variables of patients are shown in Table 1.

OPCAB SURGICAL TECHNIQUE

During OPCABG, perfusionist standby was available for all patients. Blood pressure was optimized carefully with selective use of vasoconstrictors.

Sternotomy was done in all patients. In addition to left-sided deep pericardial retraction sutures and table rotation, we always placed a right vertical pericardiotomy on the right-sided diaphragmatic surface, toward the inferior vena cava, to enter the right pleural cavity. This procedure facilitates exposure of the circumflex artery without compromising the patient's hemodynamic status. Local stabilization of the coronary artery was achieved by an Immobilizer™ Octopus 4 mechanical stabilizer (Medtronic, Minneapolis, MN, USA). For bleeding control we used an intracoronary shunt in all anastomoses. First, revascularization was performed on the left anterior descending artery (LAD), as it was the most frequent site of critical lesions. In subsequent grafting, proximal anastomosis was constructed so that the blood supply to the coronary artery could be established immediately after completion of the anastomosis. During the procedure, we used 7-0 or 8-0 monofilament continuous suture.

STATISTICAL ANALYSIS

Data were analyzed using the statistical software program SPSS for Windows version 13.0 (SPSS Inc, Chicago, IL, USA).

Table 1. Patient Preoperative Variables*

Sex (M/F)	43/13
Age, y	62.9 (51-86)
Diabetes	28
Hypertension	45
Smoking	28
Obesity	33
Renal dysfunction	9
Cerebrovascular disease	7
Intraaortic balloon pumping	12
Respirator	3
Cardiogenic shock	4
Previous myocardial infarction	3
Mean ejection fraction	
>50%	19
30%-50%	29
<30%	8

*Values are n unless otherwise stated.

Table 2. Bypass Distribution in 43 AMI Patients*

	LIMA	SVG	TOTAL
LAD	44	12	56
DG		24	24
OM		18	18
RCA		49	49
TOTAL	44	103	147

*AMI indicates acute myocardial infarction; LIMA, left internal thoracic artery; SVG, saphenous vein graft; LAD, left anterior descending artery; DG, diagonal branch; OM, obtuse marginal; RCA, right coronary artery.

RESULTS

Of 56 patients, 47 (83.9%) underwent OPCAB without subsequent conversion to on-pump CABG. Conversion to beating-heart CABG under CPB was necessary for 9 patients (16.1%) because of arrythmia and hemodynamic instabilty. The mean time duration of surgery was 215 ± 60 min, the mean number of grafts/patient was 2.5 ± 1.1, and the rate of complete revascularization was 73.2% (n = 41). Four patients died; 1 (1.7%) died of pneumonia, 1 (1.7%) of mediastinitis, and 2 (3.5%) of cardiogenic shock leading to low cardiac output.

The bypass distribution in 56 patients with AMI is shown in Table 2. The morbidity and mortality rates due to surgery are shown in Table 3.

Postsurgery elective coronary angiography (n = 21) showed no significant stenosis.

DISCUSSION

In the clinical setting, AMI patients who develop sustained elevation of enzymes (creatine kinase–myocardial band more than twice the normal value, which is <11 IU/L), elevated ST segment on electrocardiogram, and persistent chest pain and hemodynamic instability despite medical treatment are candidates for emergency CABG. The interval between AMI onset and surgery, regardless of revascularization, is a crucial predictor of operative mortality [Lee 2003], reported to be as

Table 3. Mortality and Morbidity Rates in 43 Patients

	n (%)
Hospital mortality	4 (7.1)
Perioperative myocardial infarction	6 (10.7)
Low-output syndrome	4 (7.1)
Ventricular tachycardia	8 (14,2)
Infections (major, mediastinitis)	1 (1.7)
Pneumonia (aspiration)	5 (8.9)
Gastrointestinal bleeding	2 (3.5)
Mean ejection fraction*	
>50%	19
30%-50%	27
<30%	6

*Total number of patients in this category is 52 because of 4 mortalities.

high as 5.0%-20% [Nunley 1983; Curtis 1991; Creswell 1995; Lee 2003]. Our studies included patients who had suffered an AMI during the first 12 h before surgery. It has also been reported that patients who undergo surgery within the first 6-12 hours had less mortality and morbidity than patients who underwent surgery at later times [Curtis 1991]. It has previously been reported that operative mortality rates are significantly higher for AMI patients than non-AMI patients. Thus cardiac surgery for AMI patients should be kept as minimally invasive as possible. OPCABG is gaining widespread acceptance as the preferred choice for myocardial revascularization in AMI patient with low risk [Rastan 2006].

Intrapulmonary sequestration of white blood cells with generation of oxygen free-radicals and protease enzymes causes interstitial edema, resulting in the need for postoperative ventilation [Ascione 2000]. These mechanisms, together with cerebral microembolism, also contribute to the deleterious effects of CPB on cerebral neuropsychological function. Elimination of CPB has been shown to reduce mortality and complications in some series, especially for patients who are at risk of morbidity from CPB [Cleveland 2001; Puskas 2003]. SIRS during and after cardiac surgery is primarily related to CPB [Cleveland 2001]. CABG without the use of CPB has been shown to reduce SIRS [Wan 1997; Ascione 2000]. Systemic inflammatory reaction due to CPB, global myocardial ischemia during cardioplegic arrest, and reperfusion injury just after the release of aortic cross-clamping have been described as devastating effects [Wan 1999; Angelini 2002; Eagle 2004; Wan 2004]. The advent of OPCABG has entirely changed the surgical treatment of AMI because it eliminates CPB use and all side effects associated with it [Yokoyama 2000; Rastan 2006]. Our study results demonstrate an acceptable outcome for 56 OPCAB patients who underwent surgery within 12 h of AMI. Whenever possible we used the LIMA as an arterial graft. Because of the older age of our patient population, we had to harvest the graft in a limited period of time we did not use radial artery grafts. For single arterial occlusion, we performed only LIMA-LAD anastomosis and thus did not use vein grafts in all patients.

No intraoperative deaths occurred in our patients. In-hospital deaths occurred in 4 patients (7.1%). Two of these patients had caridogenic shock preoperatively, and despite emergency CABG they died after the procedure. Cardiogenic shock is a very strong predictor of operative mortality [Mohr 1999; Ochi 2003]. Nunley et al [1983] reported that AMI patients with preoperative cardiogenic shock have very high rates of operative mortality (14.3%), and preoperative cardiogenic shock has been reported as a predictor of operative mortality. In the present study mortality was significantly higher in patients who developed preoperative cardiogenic shock (2 of 4 patients, 50%) than in patients who did not (2 of 52, 3.8%; $P < .05$). In addition, early conversion to on-pump beating-heart CABG will ensure stable systemic circulation and prevent progressive organ dysfunction in patients with cardiogenic shock. On-pump beating-heart CABG minimizes the deleterious effects of CPB by using a closed circuit and avoiding cardioplegic arrest [Declusin 2000]. The avoidance of aortic cross-clamping and cardiac arrest can contribute to myocardial protection and eliminate intraoperative global myocardial ischemia [Ochi 2003; Izumi 2006]. Our observation of an increase in early postoperative EF (Table 3) compared to preoperative EF (Table 1) supports these reported data.

The major limitation of this study was the relatively small number of patients. Because our department was founded recently, we anticipate that in the very near future we will be able to report the outcomes of a larger group of patients.

CONCLUSION

We achieved good surgical revascularization with emergency OPCABG surgeries performed within the first 12 h of AMI. In the mean time, with the help of extended and long-term studies, we anticipate that emergency OPCABG will become a standard surgical procedure for patients with AMI.

REFERENCES

Angelini GD, Taylor FC, Reeves BC, Ascione R. 2002. Early and midterm outcome after off-pump and on-pump surgery in Beating Heart against Cardioplegic Arrest Studies (BHACAS 1 and 2): a pooled analysis of two randomised controlled trials. Lancet 359:1194-9.

Ascione R, Lloyd CT, Underwood MJ, Lotto AA, Pitsis AA, Angelini GD. 2000. Inflammatory response after coronary revascularization with or without cardiopulmonary bypass. Ann Thorac Surg 69:1198-04.

Chen-Scarabelli C. 2002. Beating-heart coronary arteries bypass graft surgery: indications, advantages, and limitations. Critical Care Nurse 22:44-58.

Cleveland JC, Shroyer AL, Chen AY, Peterson E, Grover FL. 2001. Off-pump coronary arteries bypass grafting decreases risk-adjusted mortality and morbidity. Ann. Thorac. Surg. 72:1282-8.

Creswell LL, Moulton MJ, Cox JL, Rosenbloom M. 1995. Revascularization after acute myocardial infarction. Ann Thorac Surg 60:19-26.

Curtis JJ, Walls JT, Salam NH, et al. 1991. Impact of unstable angina on operative mortality with coronary revascularization at varying time intervals after myocardial infarction. J Thorac Cardiovasc Surg 102: 867-72.

Eagle KA, Guyton RA, Davidoff R, et al. American College of Cardiology; American Heart Association. 2004 ACC/AHA Task Force on Practice Guidelines: ACC/AHA 2004 guideline update for coronary artery bypass graft surgery. Circulation 110:340-437.

Izumi Y, Magishi K, Ishikawa N, Kimura F. 2006. On-pump beating-heart coronary artery bypass grafting for acute myocardial infarction. Ann Thorac Surg 81: 573-6.

Lee DC, Oz MC, Weinberg AD, Ting W. 2003. Appropriate timing of surgical intervention after transmural acute myocardial infarction. J Thorac Cardiovasc Surg 125: 119-20.

Mohr R, Moshkovitch Y, Shapira I, Amir G, Hod H, Gurevitch J. 1999. Coronary artery bypass without cardiopulmonary bypass for patients with acute myocardial infarction. J Thorac Cardiovasc Surg 118: 50-6.

Nunley DL, Grunkemeier GL, Teply JF, et al. 1983. Coronary bypass operation following acute complicated myocardial infarction. J Thorac Cardiovasc Surg 85:485-91.

Ochi M, Hatori N, Saji Y, Sakamoto S, Nishina D, Tanaka S. 2003. Application of off-pump coronary artery bypass grafting for patients with

acute coronary syndrome requiring emergency surgery. Ann Thorac Cardiovasc Surg 9:29-35.

Puskas JD, Williams WH, Duke PG et al. 2003. Off-pump coronary artery bypass grafting provides complete revascularization with reduced myocardial injury, transfusion requirements and length of stay: a prospective randomized comparison of two hundred unselected patients undergoing off-pump versus conventional coronary artery bypass grafting. J Thorac Cardiovasc Surg 125:797-808.

Rastan AJ, Eckenstein JI, Hentschel B, et al. 2006. Emergency coronary artery bypass graft surgery for acute coronary syndrome beating heart versus conventional cardioplegic cardiac arrest strategies. Circulation 114:I477-85.

Riha M, Danzmayr M, Nagele G, et al. 2002. Off-pump coronary artery bypasses grafting in EuroScore high and low risk patients. Euro J Cardiothoracic Surg 21:193-8.

Sabik JF, Gillinov AM, Blackstone EH, et al. 2002. Does off-pump coronary surgery reduce morbidity and mortality? J Thorac Cardiovasc Surg 124:698-707.

Vlassov GP, Deyneka CS, Travine NO, Timerbaev VH, Ermolov AS. 2001. Acute myocardial infarction: OPCAB is an alternative approach for treatment. Heart Surg Forum 4:147-50.

Yokoyama T, Baumgartner F, Gheissari A, Capouya ER, Panagiotides GP, Declusin RJ. 2000. Off-pump versus on-pump coronary bypass in high risk subgroups. Ann Thorac Surg 70:1546-50.

Wan S, Izzat MB, Lee TW, Wan IYP, Tang N, Yim APC. 1999. Avoiding cardiopulmonary bypass in multivessel CABG reduces cytokine response and myocardial injury. Ann Thorac Surg 68:52-7.

Wan IY, Arifi AA, Wan S, et al. 2004. Beating heart revascularization with or without cardiopulmonary bypass: evaluation of inflammatory response in a prospective randomized study. J Thorac Cardiovasc Surg 127:1624-31.

Wan S, LeClerc JL, Vincent JL. 1997. Inflammatory response to cardiopulmonary bypass: mechanisms involved and possible therapeutic strategies. Chest 112:697-702.