

Off-pump Coronary Artery Bypass (OPCAB) Is a Good Choice of Treatment for Hemodialysis-Dependent Uremic Patients with Severe Coronary Artery Disease

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ABSTRACT

Objective: Surgical revascularization for uremic coronary artery patients on hemodialysis has been a challenge for cardiac surgeons. We carried out this retrospective analysis to evaluate the role of off-pump coronary artery bypass (OPCAB) for uremic coronary artery patients in a rural community hospital in southern Taiwan. **Patients and Methods:** A retrospective chart review was done of hemodialysis-dependent uremic patients who underwent OPCAB from July 2002 through August 2004. Thirteen patients were included (3 men and 10 women, mean age 65.4±8.4 years). All patients underwent hemodialysis 1 day before the operation, and they were scheduled for hemodialysis on the first or second day postoperatively. When there was an indication, urgent hemodialysis was performed immediately after the operation. Desmopressin (1-deamino-8-D-arginine vasopressin, abbreviated DDAVP) was administered preoperatively to enhance platelet function and the pericardial-shed blood was retrieved and reinfused intraoperatively to minimize blood loss. The postoperative care was the same as ordinary practice. **Results:** Nine of the 13 patients were unstable, and thus were operated on urgently or emergently. There was one death (7.7%), one mediastinitis (7.7%), and one mediastinal bleeding requiring reexploration (7.7%). There were no postoperative strokes. The average chest tube drainage amount was 735 mL, and 12 (93.3%) patients needed blood transfusions. Only one (7.7%) patient needed urgent hemodialysis after the operation because of metabolic acidosis. The other patients did well with the scheduled hemodialysis. The average intensive care unit (ICU) and hospital stays were 2.8 and 13.3 days, respectively. One patient with preoperative repeated percutaneous nephrostomy infections developed sepsis, respiratory failure, and had prolonged mechanical ventilation and hospital stay. The others recovered uneventfully and no other postoperative infections were encountered. All patients had good symptomatic relief. **Conclusions:** OPCAB is a good choice of treatment for hemodialysis-dependent uremic patients with severe coronary artery disease. (*Tzu Chi Med J* 2005; **17**:227-231)

Key words: off-pump coronary artery bypass, coronary artery disease, uremia, hemodialysis

INTRODUCTION

Patients receiving renal replacement therapy on dialysis are at extraordinarily high risk for death. The death rate for all US dialysis patients in 1998-2000 was 236/1000 patient-year. Cardiac disease is the major cause of

death in dialysis patients, accounting for about 45% of all-cause mortality, and approximately 20% of cardiac deaths are attributed to acute myocardial infarction (AMI) [1]. In Taiwan, the prevalence rate of long-term dialysis was 1241 per million people in 1999. Among these patients, 93.7% were hemodialysis patients and 6.3% were peritoneal-dialysis patients; 47.3% were male

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and 52.7% were female. The average age was 57.5±14.8 years. Diabetes mellitus accounted for 24.8% of the primary causes of renal failure. The death rate was higher in the elderly, and the main causes of death was cardio-pulmonary diseases [2].

Dialysis patients are clearly a high-risk surgical subset for cardiac surgery. However, a number of studies have demonstrated that cardiac surgery can be performed with increased but acceptable perioperative mortality and morbidity rates, and the mortality rate ranged from 0% to 20% [3-12]. With the advent of stabilizers and sophisticated anesthesia, we perform coronary artery bypass surgery on a beating heart without cardiopulmonary bypass easily now. As the off-pump coronary artery bypass (OPCAB) becomes increasingly popular, some researchers have suggested that the postoperative recovery and morbidity may be reduced by the use of OPCAB [13-17].

In Taiwan, partly because of lack of experience and partly because of medical nihilism, coronary patients on hemodialysis are quite often not identified and are not referred to cardiologist, let alone to surgical revascularization. We herein reviewed our experience with 13 patients who were on hemodialysis and underwent OPCAB.

PATIENTS AND METHODS

We retrospectively analyzed 13 consecutive hemodialysis-dependent patients who underwent off-pump coronary artery bypass surgery in Dalin Tzu Chi General Hospital from July 2002 through August 2004. All patients were referred from nephrologists to our cardi-

ologists because of angina during hemodialysis. The treatment strategy was determined after angiographic diagnosis and discussion between cardiologists and cardiac surgeons. Results are expressed in Mean±SD.

There were three men and 10 women, and the mean age was 65.4±8.4 years (53 to 84 years). Co-morbidities included diabetes (76.9%), peripheral vascular disease (30.8%) and preoperative repeated percutaneous nephrostomy infection (7.7%). A total of 93.3% of the patients had coronary angiography during this same admission. Nearly 69.2% were unstable patients admitted to the intensive care unit and were operated on urgently or emergently. One patient who suddenly collapsed and developed acute lung edema during hemodialysis was intubated preoperatively. Left main coronary artery disease was present in 38.5% of the patients. The demographic data and characteristics of the patients are listed in Table 1.

All patients had hemodialysis 1 day before their operations, and postoperatively they were scheduled for hemodialysis on the first or second postoperative day. Fluid administration was kept to a minimum. Only if there was fluid overload, hyperkalemia, metabolic acidosis, or uremic bleeding, then urgent hemodialysis was performed after the operation.

All 13 patients underwent OPCAB. Preoperative antiplatelet drugs such as aspirin or clopidogrel were not discontinued. For patients on preoperative continuous heparin infusion, it was discontinued right before induction of anesthesia. All patients received heparin after pericardiotomy. The dosage of heparin was 200 units/kg and the activated clotting time was kept between 300 to 400 seconds. Desmopressin (1-deamino-8-D-arginine vasopressin, abbreviated DDAVP) was adminis-

Table 1. Patient Demographic Characteristics

	Dalin Tzu Chi	Khaitan et al [11]	Liu et al [19]
Overall number, n	13	70	279
Mean age, years	65.4±8.4	62.5	66.7
Male, %	30.8	62.9	66.3
Preoperative comorbidities			
Diabetes mellitus, %	76.9	57	48
Peripheral vascular disease, %	30.8	40	40.9
Cardiac profile			
Ejection fraction, %	65.6±11.7	-	47.6
Angiography this admission, %	93.3	-	6.1
No. of major coronary arteries >70% stenosis (mean)	2.8	-	2.6
Left main coronary disease, %	38.5	12	26.5
Unstable angina this admission, %	69.2	70	57.7
Preoperative balloon pump, %	0	-	7.5
Surgical priority			
Urgent /emergent operation, %	69.2	-	70.6

tered prior to sternotomy to enhance platelet function and thus to minimize blood loss. The pericardial-shed blood was retrieved and continuously reinfused intraoperatively to reduce the need for blood transfusion. Heparinization was fully reversed at the end of the operation. If there was coagulopathy, we administered cryoprecipitate. Only when there was hypovolemia secondary to blood loss did we conduct blood transfusion. Postoperatively we replaced half the amount of the mediastinal drainage with packed red blood cells or whole blood. Prophylactic antibiotics were administered 30 minutes before the operation and were redosed every 3 hours during the operation to keep high serum antibiotic concentration. The postoperative care was the same as for patients who do not need hemodialysis.

RESULTS

The operations were smooth and uneventful for all 13 patients. The mean operation time was 375 ± 90 minutes. The average numbers of anastomoses were 2.9 ± 1.0 , and left internal mammary arteries (LIMA) were used in 76.9% of patients. LIMA was not harvested in an 84-year-old woman because of limited longevity and in two other patients because of hemodynamic instability and ongoing ischemia mandating quick revascularization and initial high flow. Complete revascularization was achieved in 84.6% of patients, and only 46.2% of patients needed low-dose inotropic support during the operation, which was discontinued soon after the operation.

Intraoperative and postoperative fluid administra-

tion was kept to a minimum, and no patient had fluid overload. Preoperative serum potassium level was 4.1 ± 0.5 meq/dL, which was not significantly elevated postoperatively (4.5 ± 0.8 meq/dL). No patient had metabolic acidosis upon arrival at the intensive care unit. A 76-year-old woman suffered metabolic acidosis in the early morning of the 1st postoperative day, and underwent urgent hemodialysis. Otherwise, 93.3% of patients underwent hemodialysis according to the regular schedule.

Preoperative anemia was present in all patients (mean hemoglobin 9.21 ± 1.4 g%). Postoperatively the chest tube drainage amount averaged 735 ± 400 mL. A total of 93.3% of patients needed blood transfusions intra- or postoperatively. The mean homologous transfusion amount was 3.8 ± 2.9 units of packed red blood cell or whole blood. A 67-year-old woman was returned to the operating room for reexploration and a bleeder at the vein graft was found. The reexploration rate was 7.7%.

No special difficulties in postoperative management were encountered. The average ventilator time, intensive care unit stay, and total hospital stay were 25.2 ± 15 hours, 2.8 ± 0.9 days, and 13.3 ± 5.3 days, respectively. Extreme data were collected from a 60-year-old man with repeated preoperative percutaneous nephrostomy infection. He suffered postoperative sepsis, prolonged ventilator support, and prolonged hospital stay for 11 months. The data were dealt with separately.

There was a late re-admission due to methacillin-resistant Staphylococcal mediastinitis, which was treated using surgical debridement (7.7%). A 73-year-old woman with severe peripheral vascular disease and bilateral above-knee amputation was operated on

Table 2. Results and Complications

Number	Dalin Tzu Chi	Khaitan et al [11]	Liu et al [19]
	13	70	279
	% of patients	% of patients	% of patients
Blood component requirement			
PRBC or WB	93.3	100	-
Platelet concentration	30.8	-	-
Cryoprecipitate or FFP	15.4	-	-
Complications			
death	7.7	14.3	12.2
prolonged ventilation	7.7	26	
septicemia	14.4	10	
reexploration	7.7	10	3.6
mediastinitis	7.7	-	3.6
stroke	0	8	4.3
Hospital stay (days)	13.3 ± 5.3	24	-

-: not available; PRBC: packed red blood cell; WB: whole blood; FFP: fresh frozen plasma

emergently because of critical left main coronary artery disease and severe chest pain. Though the operation was uneventful, she died on the 3rd postoperative day because of limb ischemia and rhabdomyolysis. The mortality rate was 7.7%. In addition, there was no stroke or other postoperative infection. The results are listed in Table 2.

After discharge, only one patient reported mild angina that was easily treated medically. The others returned to their referring nephrologists and were symptom-free.

DISCUSSION

The optimal approach to revascularization in patients with kidney disease has not been determined. In a prospective study (APPROACH), Hemmelgarn et al demonstrated survival advantages for patients who underwent CABG compared with no revascularization for patients with all categories of kidney function. However, selection bias is likely in that healthier patients may have been chosen for surgical interventions [18].

Dialysis patients are clearly a high-risk surgical subset for cardiac surgery. It is known that these patients have worse outcomes than patients not on dialysis. Many studies have been published reviewing small groups of patients with varying conclusions. Some studies have demonstrated that cardiac surgery can be performed with increased but acceptable perioperative mortality and morbidity rates, and the mortality rate ranged from 0% to 20% [3-12].

Khaitan et al reported experiences with 70 uremic patients undergoing coronary artery bypass surgery [11]. The perioperative mortality rate was 14.3%, and may have been even as high as 30% for patients undergoing concomitant valvular procedures. All patients needed blood transfusion, and the mean hospital stay was 24 days. In another regional prospective cohort study of 15500 consecutive patients undergoing CABG in northern New England in the United States from 1992 to 1997, Liu et al reported that the 279 dialysis-dependent renal failure patients were 4.4 times more likely to experience in-hospital deaths [19]. They also demonstrated increased risk of mediastinitis and postoperative stroke. The risk of reexploration for bleeding was nevertheless similar to that patients not on dialysis.

The increased risks of uremic patients undergoing cardiac surgery come from pre-existing multi-system diseases, generalized atherosclerosis, heavily calcified aortae and coronary arteries, complicated intra- and postoperative management, and bleeding tendency. Main-

taining fluid and electrolyte balance during cardiopulmonary bypass is important and some modifications of cardiopulmonary bypass procedures are mandatory. Intraoperative hemodialysis (IHD) lessened postoperative hyperkalemia and metabolic acidosis and delayed postoperative hemodialysis by an additional day [20,21]. However, the complication rate is still high, and the procedures are more complex and technically demanding. Another problem is bleeding. Uremic patients have a primary hemostatic defect due to abnormal platelet-vessel wall interaction that is reflected as prolonged bleeding time. Although dialysis usually improves the hemostatic defect, improvement does not always occur. In the series by Khaitan et al., blood transfusion was required in 100% of patients [11].

Off-pump coronary artery bypass (OPCAB) seems intuitively simpler and less invasive for hemodialysis-dependent patients. With application of stabilizers, we can perform coronary anastomoses on a beating heart. Thus, we avoid performing cardiopulmonary bypass and the subsequent fluid overload, electrolyte imbalance, and aggravated bleeding disorders in uremic patients. In addition, with less manipulation of the ascending aorta, the postoperative neurological complications might be reduced. In our series, because DDAVP leads to a short-term shortening or normalization of the bleeding time in the majority of patients with uremia [22], we think preoperative administration can minimize bleeding.

However, there is little evidence for this opinion. As Hong et al. reported, OPCAB offers more advantages, including shorter operation time, less blood transfusion, less usage of inotropic agents, earlier extubation, and shorter ICU stay [17]. They did not mention their hemodialysis protocol or surgical priority, though.

We assume that the benefits of OPCAB are more prominent in our hospital since this is a rural community-hospital located in an area where people older than 65 years old consists of 14% of the population. Most of the patients were farmers and labor workers without easy access to medical attention. In our series, 69.2% of patients were unstable patients and had to be operated on urgently or emergently. In addition, the surgical volume in our hospital is low and the intensive care staff are not familiar with complicated post-cardiac surgical care. To have a simple and effective surgical procedure and a definite protocol for postoperative care is of utmost importance.

The data from our analysis are encouraging. We had more female patients, more diabetics, and more patients with left main coronary artery diseases. These are all documented risk factors for open-heart surgery. However with our simplified but standardized protocol, the

mortality and morbidity rates are acceptable. The post-operative management was straightforward and easy, and the patients recovered quickly. The length of ICU and hospital stay was reasonable.

Thus, we concluded that off-pump coronary artery bypass (OPCAB) is a good choice of treatment for hemodialysis-dependent uremic patients with severe coronary artery disease.

REFERENCES

- Herzog CA: How to manage the renal patients with coronary heart disease: The agony and the ecstasy of opinion-based medicine. *J Am Soc Nephrol* 2003; **14**:2556-2572.
- Hwang SJ: Establishment of dialysis quality indicators in Taiwan. Step two - surveillance and evaluation. *Taiwan Society of Nephrology*, 2001.
- Suehiro S, Shibata T, Sasaki Y, et al: Cardiac surgery in patients with dialysis-dependent renal disease. *Ann Thorac Cardiovasc Surg* 1999; **5**:376-381.
- Durmaz I, Buket S, Atay Y, et al: Cardiac Surgery with cardiopulmonary bypass in patients with chronic renal failure. *J Thorac Cardiovasc Surg* 1999; **118**:306-315.
- Gelsomino S, Morocutti G, Masullo G, et al: Open heart surgery in patients with dialysis-dependent renal insufficiency. *J Card Surg* 2001; **16**:400-407.
- Frenken M, Krian A: Cardiovascular operations in patients with dialysis-dependent renal failure. *Ann Thorac Surg* 1999; **68**:887-893.
- Blum U, Skupin M, Wagner R, Matheis G, Oppermann F, Satter P: Early and long-term results of cardiac surgery in dialysis patients. *Cardiovasc Surg* 1994; **2**:97-100.
- Horst M, Mehlhorn U, Hoerstrup SP, Suedkamp M, de Vivie ER: Cardiac surgery in patients with end-stage renal disease: 10-year experience. *Ann Thorac Surg* 2000; **69**:96-101.
- Owen CH, Cummins RG, Sell TL, Schwab SJ, Jones RH, Glower DD: Coronary artery bypass grafting in patients with dialysis-dependent renal failure. *Ann Thorac Surg* 1994; **58**:1729-1733.
- Castelli P, Condemni AM, Munari M: Immediate and long-term results of coronary revascularization in patients undergoing chronic hemodialysis. *Eur J Cardiothorac Surg* 1999; **15**:51-54.
- Khaitan L, Sutter FP, Goldman SM: Coronary artery bypass grafting in patients who require long-term dialysis. *Ann Thorac Surg* 2000; **69**:1135-1139.
- Batiuk TD, Kurtz SB, Oh JK, Orszulak TA: Coronary artery bypass operation in dialysis patients. *Mayo Clin Proc* 1991; **66**:45-53.
- Ascione R, Nason G, Al-Ruzzeh S, Ko C, Ciulli F, Angelini GD: Coronary revascularization with or without cardiopulmonary bypass in patients with preoperative nondialysis-dependent renal insufficiency. *Ann Thorac Surg* 2001; **72**:2020-2025.
- Hirose H, Amano A, Takahashi A: Efficacy of off-pump coronary artery bypass grafting for the patients on chronic hemodialysis. *Jpn J Thorac Cardiovasc Surg* 2001; **49**:693-699.
- Tashiro T, Nakamura K, Morishige N, et al: Off-pump coronary artery bypass grafting in patients with end-stage renal disease on hemodialysis. *J Card Surg* 2002; **17**:377-382.
- Osaka S, Ohsawa H, Miyazawa M, Honda J: Off-pump coronary artery bypass grafting in patients on chronic hemodialysis. *J Card Surg* 2001; **16**:302-309.
- Hong GJ, Lee CY, Lin CY, Yang HS, Tsai CS: Comparison of on-pump and off-pump CABG in hemodialysis patients. *Acta Cardiol Sin* 2003; **19**:212-220.
- Hemmelgarn BR, Southern D, Culleton BF, Mitchell LB, Knudtson ML, Ghali WA: The Alberta provincial project for outcomes assessment in coronary heart disease (APPROACH) investigators: Survival after coronary revascularization among patients with kidney disease. *Circulation* 2004; **110**:1890-1895.
- Liu JY, Birkmeyer JO, Sanders JH, et al: Risks of morbidity and mortality in dialysis patients undergoing coronary artery bypass surgery. *Northern New England cardiovascular disease study group. Circulation* 2000; **102**:2973-2977.
- Ilson BE, Bland PS, Jorkasky DK, et al: Intraoperative versus routine hemodialysis in end-stage renal disease patients undergoing open-heart surgery. *Nephron* 1992; **61**:170-175.
- Khoo SC, Braden GL, Deaton D, et al: Outcome and complications of intraoperative hemodialysis during cardiopulmonary bypass with potassium-rich cardioplegia. *Am J Kidney Dis* 2003; **41**:1247-1256.
- Mannucci PM: Desmopressin: A nontransfusional form of treatment for congenital and acquired bleeding disorders. *Blood* 1988; **72**:1449-1455.

