Coronary Artery Bypass Surgery in Patients with End Stage Renal Disease: Overall Outcome in Single Centre Experience

A H NAQVI Z PARVEZ F A CHAUDHARY *T SHAFI*
Department of Cardiothoracic Surgery, Sheikh Zayed Hospital, Lahore
Correspondence to Dr. Farid Ahmad Chaudhry, e-mail: farid.cahudhary@yahoo.com

Background: Coronary artery bypass surgery and its entire perioperative management is demanding in patients with end stage renal disease (ESRD). **Methods:** We included data from all patients on hemodialysis who underwent coronary artery bypass grafting (CABG) between November 1st, 2003 and November 1st, 2006 at Sheikh Zayed hospital and Federal postgraduate medical institute, Lahore, Pakistan. **Results**: During the study period 41 patients with end stage renal disease underwent coronary artery bypass grafting at the Sheikh Zayed hospital and Federal postgraduate medical institute, Lahore. Among these patients, we recorded a perioperative mortality of 19.51%. Six months survival rate was 75.60 % among study group patients. The incidence of peripheral artery disease is reported significantly higher in the dialysis dependent patients. Uremic patients showed significantly lower hemoglobin serum levels (<10mgldl) at the time of admission. These patients received significantly higher numbers of blood transfusions (≥4), fresh frozen plasmas (FFP's) when needed. **Conclusion:** Our preliminary study indicates that coronary artery bypass surgery can be performed with acceptable midterm results when the specific requirements of this patient group are taken into account.

Key words: End-stage renal disease, Coronary artery disease, Coronary artery bypass grafting

Cardiovascular disease is the commonest cause of death in end stage renal disease (ESRD) patients, exceeding in rate that of the general population[1]. In addition, cardiovascular complications are a leading cause of morbidity among ESRD patients. There is increasing emphasis on the treatment of cardiovascular disease in ESRD patients and, on the prevention of cardiovascular disease in patients with renal insufficiency.

Coronary artery disease and end stage renal disease has significant correlation[1]. Uremia is a complex syndrome that influences all the cardiac structures – the pericardium, the myocardium, the endocardium and the coronary system. Most important manifestations of this complex of symptoms, which is also called "uremic heart disease", are hypertensive heart disease and coronary artery disease[2].

When dialysis patients suffer from coronary artery disease, they often have severe, diffuse, sometimes even circular, calcifications of the coronary arteries, reaching into the periphery of the vessels. This is probably a result of uremia-associated disturbances of the calcium and phosphate metabolism. In this context, autonomous parathormone (PTH) release with consequent elevation of calcium and phosphate serum levels seems to be important. Besides this, typical comorbidities such as arterial hypertension, peripheral artery disease, hyperlipoproteinemia, renal anemia and disturbances of the carbohydrate metabolism play a significant role [3]. As a consequence, it is not surprising that cardiovascular diseases are the primary cause of death in patients requiring chronic hemodialysis.

However, chronic and especially terminal renal insufficiency is also an important risk factor for increased mortality and morbidity after cardiac operations. Only 0.5–1.5% of patients who undergo coronary operations are uremic. Their perioperative mortality, however, is between 8 and 30%. The highest risk is carried by uremic patients suffering from diabetes or peripheral artery disease[2].

Most coronary operations are performed using either the extracorporeal circulation or off-pump technique (OPCAB). Factors associated with the former technique such as deviations in fluid balance and serum electrolyte levels, hemodilution and disturbances of the coagulatory system require adjusted perioperative management of these patients. Postoperatively, they are prone to complications including septicemia, mediastinitis and prolonged bleeding. The increased incidence of postoperative bleeding may be explained by a disturbance of platelet function caused by uremia[3].

Patients and methods

In our study we analyzed data from all patients who are on regular hemodialysis and who underwent coronary artery bypass grafting between November 1st, 2003 and November 1st, 2006 at the Sheikh Zayed hospital and Federal postgraduate medical institute, Lahore, Pakistan. This is a randomized prospective trial and the data were collected prospectively from patient admitted in our unit or referred to us from other cardiac centers because of their co-existing ESRD, during above mentioned 3 years study period.

As basic data we analyzed all the factors listed in tables 1. Primary inclusion criteria for these ESRD patients with co-existing coronary artery disease is having a history of angina or profound hypotension during hemodialysis. Patients who underwent additional valve operations, who has a history of previous coronary artery surgery and who has a successful renal transplantation were excluded from this analysis.

As a routine procedure all patients underwent a preplanned workup regarding ESRD to optimize the

patient's condition for surgery. This criteria was prospectively planned before the trial with the involvement of nephrology service and all study group patients went through this same protocol given below:

1. In hospital admission 5 days prior to surgery.
2. Hemodialysis on 4th, 2nd, and 1st preoperative day.
3. Bring the central venous pressure well below 7mm of Hg on immediate preoperative period.
4. Improving the Hemoglobin >10mg/dl by preoperative packed cell transfusions.
5. Keeping serum creatinine <5 and serum Potassium (K) ≤3.5 by having three consecutive preoperative hemodialysis as mentioned above.
6. Single dose of Inject-able Vancomycin 1g once a week and inject-able Amikacin is given after 1st preoperative day hemodialysis and repeated same after each hemodialysis postoperatively.

Peroperatively rapid sequence intubation is the mode of induction of anesthesia in these cases. Restrict fluid replacement to blood losses, insensible losses, and urine output. Avoid nephrotoxins (NSAID's, IV contrast, and aminoglycosides) because even small amounts of residual renal function can be important for dialysis patients. Succsamethonium is avoided along with other floride producing drugs because of their nephrotoxic potential and renal excretion dependence. Coronary operations were performed using extracorporeal circulation or off-pump technique (OPCAB). Until March, 2006 all patients were operated, those with on pump technique were given moderate systemic hypothermia (28°C) using cold blood cardioplegia (modified Bleese's solution) for myocardial protection. During cardiopulmonary bypass, setup was primed with 1200 ml of priming solution consisting 500 ml of whole blood, 500 ml of Gelafundine (K free sol.) mixed with 10000 units of heparine sulfate and 200 ml of Hartman solution as well we performed hemofiltration to eliminate this priming volume aiming CVP around 7 cm of H_2O. Anticoagulation was established by systemic heparin application. This was adjusted by use of the activated clotting time (ACT, target range 350–500s).
While during off-pump (OPCAB) surgery systolic blood pressure was kept between 70-90mm of Hg.

Like the preoperative protocols we also devised the postoperative care protocols in these specific ESRD patients which is as follows:

1. Blood loss in surgical drains was replaced by whole blood only.
2. Intravenous fluids are restricted to 1L / 24hours to keep the patient in –ive balance.
3. Continuous non-invasive cardiac output monitoring to maintain the balance between inotropic supports and fluid balance.
4. Intra-aortic balloon pump (IABP) use when needed.
5. Hemodialysis on 2nd post operative day in ICU and on 4th post- operative day in main dialysis centre to keep the postoperative creatinine ≤6 mgldl, serum K^+ ≤5.5 and CVP ≤10.
6. $NaHCO_3$, Ca^+ and Mg^+ is to be given according to blood levels in ICU and in ward.
7. Inj. Ceftriexon Na^+ intravenously given with the interval of 12 hours.
8. Patient should not be discharged from hospital in not less than 7 post operative days.

Data from study group patients were collected for quantitative parameters as we calculated mean and SD.

Results

During the 3 years of the investigation 41 patients with end stage renal disease dialysis dependence underwent coronary artery bypass grafting at the Sheikh Zayed hospital and Federal postgraduate medical institute, Lahore, Pakistan. We analyzed 14 different preoperative parameters as listed in Table 1.

Almost all the patients operated on, received atleast one bypass graft, and the long sephanous vein graft was our first choice. Internal mammory artery (IMA) graft was not used in most of these patients. It was mostly due to the risk of IMA spasm due to high inotropic support in early post of period causing early graft closure.

As expected, we found a lower survival rate in ESRD patients during the whole follow-up period of six months. Among dialysis dependent patients we recorded a perioperative mortality of 19.51% (8 patients). Heart failure was cause of death in 4 (9.75%) of these 8 patients and the corresponding 6 months survival rates were 75.60 %. One patient required reoperation for sternal wound healing disturbance during the postoperative period. Five (12.19%) of our study group patients developed surgical wound infections.

Uremic patients showed a significantly lower hemoglobin serum level at the time of admission which is less than 10mg/dl. Therefore, these patients received significantly higher numbers of blood transfusions (≥4), as the average blood loss via drainage tubes during the first 24 postoperative hours was differed significantly from the routine patients (dialysis dependent patients 600-1100 ml). These data is summarized in table 2.

Table 1. Preoperative data of CABG patients with end stage renal disease.

Parameters	Mean±SD
Age, years	39-72 (55.5)
Gender, M:F	36 M (87.8%)– 5 F (12.19%)
LVEF, %	25 – 50 % (37.5%)
Smoking	31 (75.60 %)
Family history of IHD	33 (80.48 %)
Angina during hemodialysis	41 (100 %)
Hypotension during dialysis	28 (68.29%)

Table 2

Parameters	Absolute No.	%age
Coronary 1-vessel disease	06	14.63
Coronary 2-vessel disease	09	21.95
Coronary 3-vessel disease	18	43.90
Left main stem disease	08	19.51
Duration on dialysis < 6 months	12	29.26
Duration on dialysis > 6 months	29	70.73
Arterial hypertension	41	100
Diabetes	38	92.68
Peripheral arterial disease	23	56.09
Hyperlipidemia	39	95.12

Discussion

Cardiovascular disease is the most common cause of death in patients with end-stage renal disease (ESRD). Unfortunately, none of the clinical trials of the 1970s and 1980s comparing medical therapy with coronary artery bypass graft (CABG) surgery included patients with ESRD[3]. However, a new study by researchers from the University of California, San Francisco, and Harvard's Schools of Medicine and Public Health on 640 ESRD patients during 1994-1995 of ESRD patients suffering from multi-vessel coronary artery disease suggests that CABG is probably superior to medication alone or coronary angioplasty.

As cardiovascular disease is the primary cause of death in patients requiring hemodialysis. Hypertensive heart disease, coronary artery disease and valve disorders are the main pathologies in this patient group. Coronary artery disease in dialysis patients is characterized by severe peripheral and sometimes circumferential calcification of the coronary vessels. Since CABG shows better results than PTCA and stent implantation in dialysis dependent patients, coronary surgery seems to be an important therapeutic option[4,5]. However, dialysis patients suffer higher postoperative mortality and morbidity than other surgical coronary patients.

The overall mortality rate for ESRD patients undergoing surgery is 4-20%. The rate is increased 5-fold if surgery is emergent. Anecdotal data suggests a higher mortality in patients with near ESRD v patients with ESRD on chronic dialysis. Major causes of peri-operative death include sepsis, cardiac dysfunction, and dysrrhythmias[6].

Morbidity of ESRD patients is very high (up to 50%), presumably due to volume shifts, acid/base control, hyper- and hypokalemia, and drug toxicity. ESRD patients tend to have longer time on pressors and mechanical ventilation, more ICU days, and longer hospital length of stay. Patients with only mild renal insufficiency have increased bleeding risk, need for blood transfusions, ICU stays, and hospital length of stay[7]. Common causes of morbidity include hyperkalemia, bleeding (platelet dysfunction), infection (decreased neutrophil chemotaxis and nutrition), dysrrhythmia, anemia, hemodynamic instability, hypertension, drug toxicity, and dialysis access thrombosis. "Uremia" affects platelet function, fibroblast response to injury, and the immune system, but the "uremic toxin(s)" are controversial[6].

We identified 41 uremic dialysis dependent patients with multi-vessel coronary artery disease among our entire record of CABG patients operated on between 2003 and 2006. More than three-quarters of these patients suffered from coronary triple-vessel disease, and in most left ventricular function was already diminished. Perioperative mortality among dialysis patients was 19.51%. This accords with data given in the literature[2,6,7]. Almost all of our dialysis patients received long sephanous vein bypass grafts. As expected, we found a lower 6 months survival rate in ESRD patients during the whole follow-up period. Among ESRD patients, we found a significantly higher number of patients who suffered from additional peripheral artery disease. As expected, we found renal anemia in our ESRD patients on admission. Their serum hemoglobin levels were significantly lower, resulting higher number of blood transfusions perooperatively.

Recently Hampl et al[8] have published results which underline the importance of blood substituation in dialysis dependent patients. They found that normalization of serum hemoglobin levels leads to improved cardiac output index in dialysis dependent patients. Peroperative bleeding along with higher volume of surgical drainage probably resulted from extracorporeal circulation as well as from a disturbance of platelet dysfunction caused by uremia itself[3]. In ESRD patient coronary surgery and the entire perioperative management is demanding. However, coronary artery bypass surgery can be performed with acceptable midterm results when the specific requirements of this patient group are taken into account.

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