Outcomes of Cardiac Surgery in Patients with End-Stage Renal Failure

Son Dönem Böbrek Yetmezliği Hastalarında Kalp Cerrahisi Sonuçları

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ABSTRACT Objective: Cardiovascular diseases and cardiac complications are the major causes of death in patients with end-stage renal disease. The purpose of this retrospective study was to evaluate the operative outcome of dialysis patients undergoing cardiac surgery at a single institution, and to clarify the association between in-hospital morbidity and mortality in both dialysis and non-dialysis patients undergoing cardiac surgery. **Material and Methods:** Fifty-four dialysis-dependent renal failure patients underwent cardiac surgery. A similar number of matched controls (n= 54) were selected based on age, sex, year, type of operation and occurrence of co-morbid diseases for the purpose of this analysis. **Results:** Operations performed in the dialysis group included coronary artery bypass grafting (CABG) alone (n= 43), CABG with valve surgery (n= 4), valve surgery alone (n= 4), Benthall procedure (n= 1), and repair post-myocardial infarction ventricular septal defect (n= 1). Chronic renal failure patients had more postoperative complications and mortality rates compared with controls. There were 7 deaths in dialysis group, whereas 2 in control group (12.9% vs 3.7%). Sepsis, prolonged ventilation, stroke, and cardiac failure were the causes of death in dialysis group. **Conclusion:** Cardiac and renal function are intimately related, with each having significant influences on the other. Dialysis-dependent renal failure is associated with an increased morbidity and mortality following cardiac surgery. Our study has been limited by small numbers but, we have detected which cardiac surgery can be performed on dialysis patients with acceptable morbidity and mortality levels.

Key Words: Cardiac surgical procedures; kidney failure; dialysis

ÖZET Amaç: Kardiyovasküler hastalıklar ve kardiyak komplikasyonlar son dönem böbrek yetmezliği olan hastalarda mortalitenin en önemli nedenlerindendir. Bu çalışmadaki amaç; açık kalp cerrahisi geçiren diyaliz hastalarının mortalite ve morbidite nedenlerini, açık kalp cerrahisine giden ama diyaliz sorunu olmayan kontrol grubu olguları ile retrospektif olarak karşılaştırmaktır. **Gereç ve Yöntemler:** Diyalize bağımlı böbrek yetmezliği olan 54 hasta açık kalp cerrahisine alındı. Benzer sayıda kontrol olgusu ile; diyalize giriş yılları, yaş, cinsiyet, operasyon tipi ve eşlik eden komorbit nedenler göz önüne alınarak analiz edildi. **Bulgular:** Diyalize giren 54 hastaya; koroner arter bypas greftleme (CABG) (n= 43), CABG ve kapak cerrahisi (n= 4), Benthall prosedürü (n= 1), miyokard infarktüs sonrası ventriküler septal defekt tamiri (n= 1) yapıldı. Kronik böbrek yetmezliği olan hasta grubunda operasyon sonrası komplikasyon ve mortalite oranı kontrol grubu ile karşılaştırıldı. Kontrol grubunda mortalite iki hastada (%3.7) görülürken diyalize giren hastalarda mortalite yedi olguda (%12.9) görüldü. Sepsis, uzun süreli ventilasyon, inme ve kalp yetmezliği diyaliz hastalarında mortalitenin en önemli nedenleri olarak saptandı. **Sonuç:** Kardiyak ve renal fonksiyonlar birbiriyle yakın ilişkilidir ve herhangi birinde olan bir problem diğerini de yakından ilgilendirmektedir. Kalp cerrahisi geçiren diyalize bağımlı böbrek yetmezliği olan hastalarda; operasyon sonrası meydana gelen morbidite ve mortalite ile yakından bir ilişki vardır. Bu çalışmamızda hasta sayımız sınırlı olsa da açık kalp cerrahisine giden diyaliz morbidite ve mortalite sonuçlarının; iyi hasta takibiyle kabul edilebilir düzeylerde olduğunu tespit ettik.

Anahtar Kelimeler: Kardiyak cerrahi prosedürler-girişimler; böbrek yetmezliği; diyaliz

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Cardiovascular diseases and cardiac complications are the major causes of death in patients with end-stage renal disease.[1] Dialysis patients are undergoing coronary artery bypass grafting (CABG) with increasing frequency. However, the perioperative risk from cardiovascular intervention has been significantly increased compared to the general cardiac patient population, and post-operative survival has been relatively low.[2] Detailed analysis of intraoperative and postoperative complications are performed in several number of studies.[3-6] There are limited number of studies identifying the intraoperative and postoperative complications of major cardiovascular (CV) surgery in chronic renal failure (CRF) patients as compared with non renal failure directly matched controls.[7,8]

The purpose of this retrospective study was to evaluate the operative outcome of dialysis patients undergoing cardiac surgery at a single institution, and to clarify the association between in-hospital morbidity and mortality in both dialysis and non-dialysis patients undergoing cardiac surgery.

MATERIAL AND METHODS

Fifty-four consecutive patients with end-stage renal failure maintained either on chronic dialysis or continual ambulatory peritoneal dialysis (1 patient) preoperatively who underwent cardiac surgery at Gazi University Medical Faculty between the years of 1998 and 2009 April were included in this study. Appropriate control data, matched for age, sex, diabetes, and type and year of surgery were randomly selected from our database. These factors were selected as they are possible important risk factors for mortality and were readily available from our database. The inclusion of the year of operation was meant to eliminate any differences in operation results over the eleven-year period. It was, however, not possible to match the groups perfectly.

The perioperative dialysis program consisted of the following procedures: dialysis the day before operation, hemodialysis during the cardiopulmonary bypass, and resumption of dialysis the first or the second day after operation. Dialysis was performed based on the observation of the serum creatinine level within 48 hours after the operation. If the serum creatinine level was higher than the preoperative value by 10% or more the hemodialysis was performed. Hemodialysis was performed in all patients with the exception of 1 patient who was on chronic ambulatory peritoneal dialysis for 4 years and was treated by peritoneal dialysis pre- and postoperatively.

Operative details included median sternotomy, cardiopulmonary bypass with moderate hypothermia, and hemodialysis while on bypass with pump flow rates of 1.6 ± 2.2 l / min per m^2 and arterial pressure maintain greater than 65 mmHg by fluid filling or use of vasoconstrictive drugs when appropriate. The extra corporeal circuit was routinely primed with isotonic cristalloid solution or with fresh plasma and fresh blood added to maintain hematocrit higher than 25 %. Myocardial protection was achieved, in all patients by blood cardioplegia and topical cooling. Except for patients who needed to be put on CPB in a hurry, the left internal mammary artery (IMA) was used whenever possible and combined with saphenous vein grafts in CABGs. Proximal anastomosis were performed during aortic cross-clamping .

The operation was considered emergent when it was done nonelectively within 24 hours of the decision to proceed with cardiac surgery regardless of the patient's hemodynamic status. The hospital mortality rate included deaths within 30 days of operation or during the same hospitalization.

Statistical Analysis

All statistical analyses were performed with SPSS for Windows statistical package version 12. Descriptive statistics were expressed as mean values standard deviation or as percentages. An independent samples *t* test was used to compare the noncategoric or continuous variables. Comparison between groups for categorical variables was made by X^2 test and Fisher's exact test was used if the sample size was smaller. Statistical significance was assumed if the *p* value was less than 0.05.

RESULTS

Patients demographics and preoperative variables are listed in Table 1. Demographics did not differ,

TABLE 1: Patients demographics and preoperative variables.

Baseline characteristic	Dialysis group	Control group	p
No. of patients	54	54	ns
Gender (Male/Female)	39/15	37/17	ns
Age (year)	62 ± 9.9	59.6 ± 10.3	ns
Hypertension (%)	85.1	75.9	ns
Hyperlipidemia (%)	57.4	61.1	ns
Diabetes (%)	61.1	50	ns
Cerebrovascular disease (%)	16.6	5.5	< 0.05
Pulmonary disease (%)	20.3	16.6	ns
Atrial fibrillation (%)	29.6	24	ns
Previous MI (%)	72.2	75.9	ns
Obesity (%)	25.9	20.3	ns
Peripheral vascular disease (%)	16.6	12.9	ns
Smoking history (%)	31.4	38.8	ns
Previous open heart procedure	5.5	7.4	ns
Number of diseased vessels			
1 vessel	7	10	ns
2 vessels	20	19	ns
3 vessels	12	11	ns
> 3 vessels	4	5	ns
Valve surgery with CABG	4	3	ns
Valve surgery alone	5	4	ns
Post-MI VSD	1	1	ns
Benthall procedure	1	1	ns
LVEF < 45 %	35.1	31.4	ns
History of VT / VF	5.5	3.7	ns
NYHA ≥ 3	29.6	25.9	ns
CCS ≥ 3	59.2	66.6	ns

MI: Myocardial infarction, LVEF: Left ventricular ejection fraction, CABG: Coronary artery bypass grafting, VT/VF: Ventricular tachycardia/ventricular fibrillation, NYHA: New York Heart Association, CCS: Canadian Cardiovascular Society, VSD: Ventral septal defect, ns: Not significant.

except for cerebrovascular event which was more prevalent among CRF patients ($p< 0.05$).

There were 41 (76 %) male patients, and the mean age was 62 ± 9.9 years (range, 37 to 83 years). Patients had been on dialysis at least 1 month, with a mean duration of 51.6 ± 6 months (1 to 192 months) before the CABG. These data including causes of renal failure were also implicated in Table 2.

The surgical variables are summarized in Table 3. 2842 procedures are included in this audit, representing a rate of around 346 per year. In this series, there were 54 patients included in the 'dialysis' category. These were unevenly distributed across the 11 years of data collection, with 5 patients included in 1995, 1996, 2001 and 2005 (0.17% of total caseload), 4 in 1997, 2002, 2003 and 2004 (0.14%), 6 in 1998, 1999 and 2000 (0. 21%). This year-to-year variation was not statistically significant ($p = 0.34$).

Operations performed in the dialysis group included CABG alone (n= 43), CABG with valve surgery (n= 4), valve surgery alone (n= 4), Benthall procedure (n= 1), and repair post-myocardial infarction ventricular septal defect (n= 1).

Chronic renal failure patients had more postoperative complications and mortality rates compared with controls. There were 7 deaths (30 day mortality) in dialysis group, whereas 2 in control one (12.9 % vs 3.7 %). Sepsis (3 patients), prolonged ventilation (1 patient), stroke (1 patient) and cardiac failure (2 patients) were the causes of death in dialysis group. Table 4 and Table 5 show the results of post-

TABLE 2: Study patients' chronic renal failure profile.

Preoperative dialysis	Values
Duration (month)	51.6 ± 6
Mean age (year)	62 ± 9.9
Range (month)	1-192
Type	
Hemodialysis	53
CAPD1	
Causes of chronic renal failure	
Diabetes	21 (38.8%)
Chronic glomerulonephritis	17 (31.4%)
Systemic lupus erythamatosus	2 (3.7%)
Nephrosclerosis	1 (1.8%)
Polycystic disease	1 (1.8%)
Unknown	12 (22.2%)

CAPD: Chronic ambulatory peritoneal dialysis.

TABLE 3: Operative variables.

Event	Dialysis group	Control group	p
CPB (min)	106.6 ± 41.4	86.4 ± 54.6	0.06
AXC (min)	61.6 ± 31.7	50.8 ± 29.2	0.12
Graft number	3.1 ± 1.2	2.9 ± 1.4	0.9
Urgency n*/%	3/5.5	5/9.2	0.9
IMA use n*/%	47/87	42/77.7	0.11

CPB: Cardiopulmonary bypass, **AXC:** Aortic cross clamp, **IMA:** Internal mammary artery, **n*:** number of patients

TABLE 4: Complications.

Complication	Dialysis group	Control group	p
Death (30 day)	12.9%	3.7%	0.03
Prolonged ventilation (hr)	31.3 ± 21.6	8.1 ± 11.3	0.01
Pneumonia	5.5%	1.8%	0.08
Deep sternal infection	7.4%	3.7%	0.16
Red cell transfusions	4.9 ± 5.6	2.2 ± 3.9	0.04
Fresh frozen plasma	3.4 ± 5.1	2.8 ± 3.1	0.19
Platelet transfusions	1.8 ± 0.9	0.2 ± 1.1	< 0.01
Reoperation for hemorrage	16.6%	3.7%	< 0.01
Post-operative MI	3.7%	1.8	0.11
ICU stay (day)	9.6 ± 11.7	4.6 ± 3.2	0.03
Length of hospitalisation (day)	12.1 ± 9.4	7.2 ± 6.0	0.02
IABP use	9.2%	5.5%	0.04
Cardiac arrhythmias	14.8%	5.5%	< 0.01
Stroke	5.5%	1.8%	0.03

ICU: Intensive care unit, IABP: Intraaortic balloon pumping, MI: Myocardial enfarction.

TABLE 5: Long term survival rates.

Years of survival	Dialysis group (%)	Control group (%)	p
1 year survival	72	92	0.03
3 year survival	48	87	0.04
5 year survival	44	81	0.03

operative mortality and morbidities, long term survival rates in dialysis patients compared with nondialysis patients respectively. Statistically significant differences were observed in the risks of prolonged ventilation, reoperation for bleeding, use of blood products, intraaortic balloon pumping (IABP) need, intensive care and hospital stay, cardiac arrythymias and stroke in the postoperative period.

DISCUSSION

Cardiac and renal function are intimately related, with each having significant influences on the other. Risks for cardiovascular disease including congestive heart failure, ischemic heart disease, and peripheral vascular disease in patients with dialysis or nondialysis-dependent renal failure appears to be greater than in the general population. Both coronary risk factors such as hypertension, smoking, diabetes and hyperlipidemia and uremia-specific risk factors such as renal function impairment, anemia, and hyperparathyroidism contribute to the prevalence of these disorders in patients with renal failure.[9,10] We could demonstrated that preoperative data are not different in CRF patients except cerebrovascular events compared with matched controls. Although, it was not possible to match the groups perfectly, the selection criteria seemed to be satisfactory.

CRF patients also have a higher prevalence of non-traditional risk factors such as hyper-homocystinemia, inflammation, and oxidative stress, which may result in acceleration of atherosclerosis.[11,12] Dearrangement of calcium-phosphate homeostasis, endothelial dysfunction, conditions promoting coagulation, anemia, albuminuria and elevated uric acid levels have all been noted in the published literature.[13] Stroke incidence was found elevated in study group which might have been due to those mechanisms.

We found that CRF patients have an increased need of blood products during their hospitalization. We concluded that transfusions of both red cells were twice as high as for controls. The need for platelets was almost nine times as high. Reoperation for bleeding were also found to be higher. Dialysis patients are at increased risk of postoperative bleeding, partly as a result of platelet dysfunction and coagulation defects. Prolonged CPB might also have been played a role in this analysis. Our figures are comparable with those of other series.[14,15,16]

Postoperatively, the need for ventilation support, intensive care unit stay and hospital stay were increased in CRF patients and which is consistent with some other studies.[7,8,14,17,18] CPB causes large fluid shifts in different body compartments, and patients with dialysis-dependent renal failure have a reduced ability to handle these fluxes. Our belief is that the increased risk of prolonged ventilation in patients on dialysis after cardiac surgery can be attributable to this reason, with large fluid shifts across the pulmonary vascular bed affecting oxygenation and hence respiratory status. In addition, the metabolism of anesthetic agents in these patients is retarded and the effect of anesthesia might be prolonged.

We have shown a trend for an increased risk of postoperative arrhytymias - mainly atrial fibrillation - between dialysis and non-dialysis patients. Since the regulation of the electrolyte homeostasis depends on normal renal function, patients with acute or chronic renal disease tend to develop such disturbances. Adverse systemic effects of renal dysfunction were augmented by the use of CPB, which is known to cause fluid shifts, electrolyte imbalances, and whole body inflammation which are determinants of arrhytymias.[19]

Owing to poor water clearance and excessive interstitial fluid, a history of congestive heart failure is frequently observed in these group of patients. Operation time is also a factor to be considered here. Although not statistically significant, we have observed prolonged operation time in dialysis group. Patients with ESRF often have poor target vessels, often with diffuse disease, making the coronary anastomosis a technically more demanding procedure, and contributing to increased time on cardiopulmonary bypass, elevated arrhytymia occurance and thus need for IABP.

Early mortality in CRF patients in our material was 12.9 %, which is in the middle range of recently reported figures.[13,20] The lower mortality rate in our study may be explained by a low proportion of high-risk and combined procedures. Sepsis was the most common cause of mortality in CRF patients. Patients with chronic renal failure have increased rates of infections due to decreased chemotaxis, lymphopaenia, decreased cell-mediated immunity, and reduction in cytokine and monocyte function.[8] The adverse effects of CBP can aggravate this scenario.

Our clinical observation is that dialysis patients may present with two different patterns of coronary artery disease. Some present with typical proximal obstructions and reasonably good distal vessels; however, a second group will present with severe distal disease in addition to proximal obstruction.

The great majority of our patients enjoyed excellent relief of angina immediately after operation. More gratifying was the term maintenance of freedom from angina on mid-term follow-up, confirming the results Franga et al demonstrating the success of CABG in accomplishing its first goal of relieving angina.[18] This result was especially important to our patients, who preoperativly were having great difficulty undergoing dialysis because of angina.

Coronary artery bypass grafting can be performed on dialysis patients with acceptable morbidity and mortality. Our study has been limited by small numbers and its retrospective nature, and we would like to undertake further work with longer follow-up and quality of life assessment, as the long term benefits of cardiac surgery in end-stage renal failure patients has yet to be fully established.

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