Mortality and results after cardiac surgery in patients with end-stage renal disease

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To assess risk and intermediate results, 36 consecutive patients with end-stage renal disease (ESRD) who underwent 36 cardiac operations at The Cleveland Clinic Foundation from 1980 to 1986 were studied. Such surgery can be done with acceptable risk and yields satisfactory symptomatic relief. Survival at five years after operation equals that of the general ESRD population, but is lower than that of nonuremic patients after cardiac surgery. This is largely influenced by the high prevalence of noncardiac morbid conditions in the ESRD group.

Index terms: Heart surgery • Kidney diseases

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Long-term survival in patients with end-stage renal disease (ESRD) on maintenance dialysis therapy is adversely affected by a high incidence of atherosclerotic heart disease, probably caused by persistent hypertension.[1,2] Cardiovascular disorders are the most common cause of death in patients undergoing hemodialysis[3]; these patients have a cardiovascular mortality approximately three times that of an age-matched nonuremic control population. Several studies have shown the relative safety of cardiac surgery in this group of patients with ESRD.[4–6] Based on our own experience and that of other groups, we continue to evaluate and undertake cardiac surgical treatment in this special subset of patients.

63

Table 1. Types of renal pathology

Pathology	No. of patients	Percent
Glomerulonephritis	12	33.3
Pyelonephritis	2	5.6
Polycystic kidneys	5	13.9
Nephrosclerosis	9	25.0
Systemic lupus erythematosus	3	8.3
Buerger's disease	1	2.8
Diabetes mellitus	4	11.1
TOTAL	36	100.0

Table 2. Type of cardiac procedure

Procedure	No. of patients	Percent
CABG × 5	2	5.5
CABG × 4	8	22.2
CABG × 3	11	30.6
CABG × 2	3	8.3
CABG × 1	5	13.9
CABG × 3 plus carotid endarterectomy	1	2.8
CABG × 1 plus pericardiectomy	1	2.8
MVR	2	5.5
AVR	2	5.5
Pulmonic valvotomy	1	2.8
TOTAL	36	100.0

CABG = coronary artery bypass, *MVR* = mitral valve replacement, and *AVR* = aortic valve replacement.

Materials and methods

The records of 36 consecutive patients with ESRD who underwent coronary artery bypass or valvular heart surgery from 1980 to 1986 at The Cleveland Clinic Foundation were reviewed for preoperative and operative data. Follow-up data were obtained by trained research personnel by direct telephone call to the patient or the referring physician. All data were computerized for analysis. Kaplan-Meier estimates were used to generate the survival curves. Comparisons between curves were done using the generalized Wilcoxon test statistic. All statistical analyses were done using the SAS software package.

There were 28 men and eight women (age range, 31–75 years [mean, 51 years]). Twenty-seven patients (75%) were either current smokers or had a history of cigarette smoking, and 31 (86%) had a history of hypertension. Nine patients (25%) had diabetes mellitus. Fourteen patients (40%) had significant peripheral vascular occlusive disease (PVOD), two of whom had preoperative histories of transient ischemic attacks.

Thirteen patients (36%) had previous myocardial infarction.

One patient had undergone previous coronary artery bypass grafting (CABG), and one patient had undergone two previous mitral valve replacements. Seven patients had undergone prior kidney transplantation, four of which were unsuccessful. Seven patients were on steroid therapy prior to surgery.

The most common cause of ESRD was glomerulonephritis (12 patients, 33%), followed by nephrosclerosis (9 patients, 25%) (*Table 1*). All patients had a history of having undergone either hemodialysis or peritoneal dialysis preoperatively for a period of 1 day to 156 months (mean, 24.3 months).

Symptoms and preoperative assessment

Angina pectoris was the most common symptom, occurring in 23 patients (64%), while peripheral edema (7 patients, 19%), orthopnea (7 patients, 19%), and paroxysmal nocturnal dyspnea (six patients, 17%) were less common. Preoperative NYHA functional class was: I, seven patients (19%); II, 12 (33%); III, 13 (36%); and IV, four (11%).

All patients underwent preoperative coronary arteriography and left ventriculography, and in cases where valve repair or replacement was considered, right-sided heart catheterization was selectively performed. Left ventricular function as assessed by right anterior oblique ventriculography was normal in 17 patients (47.2%), mildly impaired in five (13.9%), moderately impaired in 10 (27.8%), and severely impaired in four (11.1%). Coronary arteriography in patients who underwent CABG identified critical lesions defined as having greater than 50% stenosis. This revealed triple-vessel disease in 17 patients (55%), double-vessel disease in eight (26%), and single-vessel disease in six (19%).

Preoperative and operative treatment

Preoperative hemodialysis or peritoneal dialysis was generally carried out the day before surgery and resumed on the first or second postoperative day, except in patients with functioning renal transplants (three patients).

All operations were performed with cardiopulmonary bypass (CPB), and systemic cooling was uniformly employed. The majority (27 patients, 75%) were done using cold cardioplegic arrest. Anoxic arrest with topical hypothermia was used in one patient, and arrest without topical cooling

in eight patients. A hemofiltration unit was used intraoperatively to remove excess fluid in nine patients. Average aortic cross-clamp time was 41 minutes.

Procedures performed are listed in *Table 2*. These included isolated CABG with saphenous vein grafts (SVG) only (N=21), CABG using an internal thoracic artery with or without SVG (N=8), aortic valve replacement (N=2), mitral valve replacement (N=2), pulmonic valvotomy (N=1), bypass plus pericardiectomy (N=1), and bypass plus carotid endarterectomy (N=1). The average number of vessels bypassed was 2.9 per patient.

Postoperative management included evaluation of serial electrocardiograms and measurement of creatinine phosphokinase enzyme and isoenzyme fractions. Intravascular volume was monitored with the use of a pulmonary artery thermodilution catheter, and electrolyte balance was carefully maintained. Patients under 70 years old and without active peptic ulcer disease who received SVG were given aspirin (325 mg) and dypiridamole (75 mg three times daily).

Results

In-hospital mortality and morbidity

There were two in-hospital deaths (5.6%). When separated by type of operation, this represents a mortality of 3.2% for those patients undergoing CABG (one of 31), and 20% for those undergoing valvular procedures (one of five).

The first death occurred in a 59-year-old woman who had undergone two previous mitral valve replacements. The patient had severe calcific obstruction of her Carpentier-Edwards mitral prosthesis. Cardiac arrest occurred on induction of anesthesia. Though she was able to be removed from CPB by using high doses of inotropes, she died the following day. The autopsy revealed a large left ventricular infarction. The second patient was a 75-year-old man who underwent four-vessel CABG without perioperative problems, but succumbed as a result of sudden cardiac arrest on the 25th postoperative day while undergoing treatment for severe depression.

Mean postoperative stay was 11.4 days for the 34 hospital survivors. One patient required the use of postoperative intra-aortic balloon pumping and suffered a perioperative myocardial infarction after a reoperation for MVR. Four patients

Table 3. Late events (excluding death)

Type of event	No.	Mean interval from open heart surgery (months)
Cardiac		
Angina	1	51
Congestive heart failure	1	51
Stroke	1	37
Noncardiac-nonrenal		
Gastrointestinal	4	29
Pneumonia	1	17
Abdominal aortic aneurysm	1	4
Sepsis	3	25
Parathyroidectomy	1	3
Leg amputation	1	19
Deep venous thrombosis	1	59
Miscellaneous	5	19
Renal		
Access procedures	2	45
Renal transplantation	8	14
Miscellaneous	8	19
	39	20

Table 4. Late deaths

Cause of death	No. of patients	Mean interval from open heart surgery (months)
Sepsis after renal transplantation	4	13
Sepsis (other causes)	2	15.6
Stroke	1	28
Dissecting thoracic aorta	1	24
Elective withdrawal from hemodialysis	1	53
Renal	2	20.5
Myocardial infarction	1	40
Suicide	1	16
Peripheral vascular	1	43
	14	23.4

(11%) had to be returned to the operating room because of excessive bleeding. Two patients (6%) required prolonged use of inotropic agents (>48 hours), and four patients (11%) required medical therapy for ventricular arrhythmias in the early postoperative period. Two patients suffered from metabolic encephalopathy, which resolved within one week postoperatively, and one patient had bilateral foot drop after CABG. There was one superficial wound infection, and one patient required replacement of an arteriovenous dialysis shunt for sepsis caused by *Staphylococcus aureus* in the existing shunt.
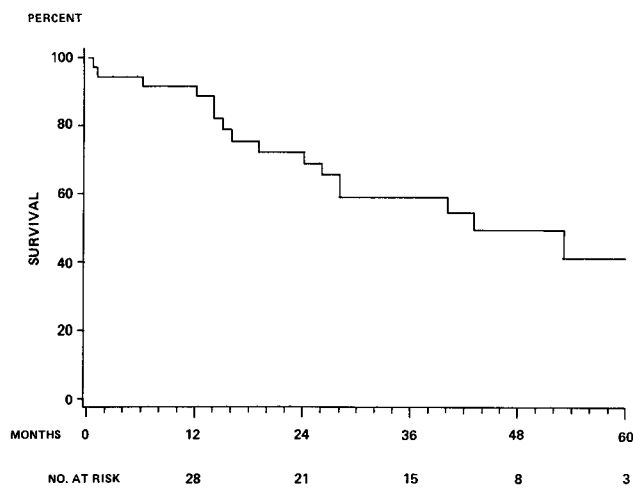
Figure. Overall survival in ESRD patients undergoing cardiac surgery.

Late events

Late events were defined as complications occurring after hospital discharge and were categorized as follows: cardiac, renal, noncardiac-nonrenal, and death (*Tables 3* and *4*). Any hospitalization was considered a late event.

The most common single event following open heart surgery was renal transplantation (eight patients). Noncardiac-nonrenal events were varied and were the second most numerous events as a group. Two patients were hospitalized for angina in the follow-up period. One of these was restudied 31 months after two-vessel CABG and found to have patent SVGs to the left anterior descending and right coronary arteries, however, he had ungraftable progressive disease in the diagonal and circumflex vessels. One patient who had preoperative evidence of diffuse PVOD had a stroke 37 months after single vessel bypass and had a partial recovery, and one hemodialysis patient was hospitalized for congestive heart failure 51 months after CABG.

There were 14 late deaths (41%) occurring a mean of 23.4 months after operation. Nearly half of these were due to sepsis with four of six patients dying of sepsis following renal transplantation.

Survival and functional class

Follow-up of the 34 hospital survivors at a mean of 31.6 months (range, 0.5–76 months) revealed an actuarial overall survival of 69% and 41% at two and five years (*Figure*). No significant difference was seen in the survival curves for diabetic patients *v.* the entire group of CABG patients. NYHA functional class of the 20 late survivors was I, 15 (75%) and II, five (25%).

Eleven patients had functioning renal transplants following open heart surgery (three prior to open heart surgery plus the eight patients who underwent renal transplantation following open heart surgery). There were four deaths in this group occurring a mean of 15 months after open heart surgery and all were due to sepsis following renal transplantation. The remaining seven patients were alive 12–46 months after open heart surgery.

Discussion

Patients with ESRD are a difficult subset of cardiac patients in that concurrent medical problems are much more common than in the nonuremic population with coronary or valvular heart disease.[7] In addition to renal failure, 86% of the patients in this study had hypertension, 25% had diabetes, and 40% had documented peripheral vascular occlusive disease. This high prevalence of concurrent morbid conditions adversely influences both early and late results when compared to a population of cardiac patients without such conditions. Treatment of a single condition (in this case, cardiac disease) may not alter the long-term survival of a population subject to multiple afflictions, and results of studies involving hospital morbidity and mortality and late events must therefore be interpreted in light of this.

In the present study, the overall hospital mortality was 5.6%. This compares favorably with other recent studies of ESRD patients,[5,6] and the 3.2% mortality in the CABG group approaches the 1%–3% mortality seen for elective coronary bypass surgery in nonuremic patients.

The number of valve operations in this study was relatively small, and results may overestimate the actual in-hospital mortality for valvular surgery in this population. The 20% mortality for valvular operations (one patient in five) occurred due to a woman undergoing a third MVR. Though high, this mortality rate is similar to that of a larger mixed group of patients recently studied in this institution who underwent a second replacement of a mitral prosthesis, for which the overall mortality was 25%.[8]

The goal of operation was to ameliorate symptoms and to decrease cardiac-related late morbidity and mortality. In some cases, CABG was undertaken prior to planned renal transplantation.

Symptomatic relief is evidenced by the fact that, at follow-up, 75% and 25% of patients were NYHA functional class I and II, respectively, whereas preoperatively 47% were functional class III or IV. Although two patients were hospitalized for angina in the follow-up period, the only documented case of myocardial infarction (which was fatal) occurred in a patient 40 months following CABG. The single hospitalization for congestive heart failure is included in the cardiac category of events, but occurred in a post-CABG patient as a result of excessive fluid intake. This responded to fluid removal by hemodialysis. Overall, cardiac-related events accounted for slightly more than 10% of the total nonfatal late hospitalizations.

When the late events and late deaths are examined, the vulnerability of this group of patients to multiple morbid conditions is underscored by the high number of noncardiac late hospitalizations. Of note is that 79% (11 of 14 patients) of the late deaths were due to noncardiac causes, with three patients dying due to cardiac-related events (one myocardial infarction, one stroke, and one dissecting aortic aneurysm).

Sepsis remains an important cause of morbidity and mortality in the ESRD population since it was responsible for 43% (six of 14 patients) of the late deaths, with post-transplantation sepsis accounting for four of these deaths. The use of cyclosporine A may result in fewer septic complications of renal transplantation, however, those patients on chronic hemodialysis will still be vulnerable to overwhelming sepsis. This typically takes the form of *Staphylococcus* sepsis arising from contamination of puncture sites in dialysis access shunts.

Distressing also is the fact that two patients died of suicide or withdrawal from the hemodialysis program. This problem reflects the considerable psychiatric morbidity in being a chronic dialysis patient.

Death rates as high as 25% per year in nondiabetic ESRD patients who have a history of coronary artery disease prior to institution of dialysis have been reported.[9] The 41% actuarial five-year survival in the present group of patients at high risk for cardiac deaths represents an improvement, with a survival rate equal to that of the general ESRD population, whose overall five-year survival ranges from 25%–65%.[10,11]

Conclusion

This review has shown that patients with ESRD can undergo cardiac surgery safely, with a hospital mortality rate similar to that seen in elective cardiac procedures in the nonuremic population. Strict control of fluid and electrolyte balance is necessary in the perioperative period. Relief from symptoms is accomplished, and survival equals that of ESRD patients without significant coronary artery or valvular heart disease, although the long-term survival is significantly worse than the general nonuremic population.

Future improvement in late survival will be associated with a decrease in the septic complications of RTP and dialysis, though late mortality will still be affected by numerous other concurrent conditions.

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