OPEN HEART SURGERY IN PATIENTS WITH END-STAGE RENAL DISEASE

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Summary
Seventeen patients on maintenance dialysis therapy or with severe impaired kidney function required correction of cardiovascular diseases by open heart surgery. Ten aortic, two mitral valvular replacements and five coronary artery bypass grafts were performed. Special attention was taken for these patients, including pre-operative dialysis, cardiopulmonary bypass with complete haemodilution, composition of extracorporeal circuit volumes, arterial and venous access and myocardial protection.

Prosthetic valves were preferred to porcine heterografts for valve replacements and autogenous saphenous veins were utilised for coronary artery bypass grafts. Follow-up of 14 patients was available from one to 84 months. Carefully planned open heart surgery can be successfully carried out in uraemic patients without an increased operative risk.

Introduction
The number of patients on dialysis and transplantation programmes is steadily increasing [1]. The prolongation of life in these patients has gradually improved with an overall expected yearly mortality rate of 10 per cent [1,2]. Cardiovascular diseases are recognised as accounting for approximately one-half of all mortalities reported in haemodialysis patients [1–3]. Myocardial infarction and other cardiac diseases are the immediate causes of death in about one-third of the fatalities in the haemodialysis population of the Diaphane Registry in France [2].

Co-existence of coronary artery disease or valvular heart disease and chronic renal failure presents a challenge when patients require major surgical procedures which have acceptable morbidity and mortality [4]. Careful consideration must be given to the special management problems associated with chronic renal failure and open heart surgery and close co-operation must be maintained between the surgeon, cardiologist, nephrologist and anaesthetist.
Clinical data and management

Patients

From October 1974 to December 1982, 17 major cardiac operations requiring cardiopulmonary bypass were performed on 17 patients with end-stage renal failure. These 17 surgical procedures were as follows: eight aortic valve replacements (three for endocarditis, one aortic valve replacement for bacterial septal aneurysm), two mitral valve replacements, one Pezzi Laubry syndrome (intraventricular communication associated with aortic insufficiency) and five coronary artery bypass grafts (CABG).

The 17 patients (14 males and three females) ranged in age from 27 to 58 years (mean age 38.2 years). Of this group, 11 patients were treated by intermittent haemodialysis for one to 84 months (average 18 months), two patients by continuous ambulatory peritoneal dialysis (CAPD) for seven and 40 months respectively, one patient was operated on after five years on haemodialysis followed by two years with a poorly functioning kidney transplant (creatinine clearance 12ml/min), three patients had severe renal failure (creatinine clearance less than 10ml/min) at time of surgery and began dialysis therapy two to four months after the surgical procedure.

The aetiology of renal failure was chronic glomerulonephritis in 11 patients, pyelonephritis: two, diabetic nephropathy: one, nephroangiosclerosis: one, polycystic kidney disease: one and unknown nephropathy in one. Most patients were suffering from multiple associated diseases: hypertension in five patients, hyperlipidaemia: six, secondary hyperparathyroidism: eight and peripheral vascular disease: five. Four patients with previous arteriovenous fistula infections (staphylococcus epidermidis in two, staphylococcus albus in one, and an unknown organism in the last) had a bacterial endocarditis.

Clinical cardiac functional status was defined pre-operatively. The four patients with bacterial endocarditis were in class IV in the New York Heart Association (NYHA) functional classification. In the seven patients suffering from rheumatic valvulopathy (two mitral, five aortic) two were in class IV and five in class III. The Pezzi Laubry syndrome was in class III with severe pulmonary hypertension. The five patients who received coronary grafts were in class IV. Four patients had a previous history of myocardial infarction and four were suffering from angina pectoris.

Management

Pre-operative preparation, centred around adjustment in fluid and electrolyte balance by dialysis. Immediately pre-operatively patients required normal dialysis treatment in order to lower serum potassium and to reach an ideal dry weight. When necessary patients were transfused with packed red cells to increase their haematocrit to 30 per cent. For patients on CAPD treatment was stopped immediately pre-operatively and patients were operated with an empty peritoneal cavity. Induction and maintenance of anaesthesia was routine using sodium pentothal, curare, morphine and nitrous oxide.
Cardiopulmonary bypass was instituted with complete haemodilution. Arterial cannulation was performed in the aorta in 14 cases and in the external iliac artery in three cases. For the venous cannulation two large venous cannulae were inserted through the appendage of the right atrium into the superior and inferior venae cavae. The arterial blood pressure, usually monitored by an indwelling catheter inserted in the radial artery, was controlled in these patients by cannulation of pedal artery in six cases, femoral artery in eight cases, and contralateral radial artery in three cases. Only internal and external jugular veins were used as venous access. The composition of the extracorporeal circuit is given in Table I. Heparisation of the pump was normal.

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<thead>
<tr>
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<th>Normal patients</th>
<th>Dialysis patients</th>
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<tbody>
<tr>
<td>Ringer’s lactate</td>
<td>500ml</td>
<td>200ml</td>
</tr>
<tr>
<td>Bicarbonate 14%</td>
<td>500ml</td>
<td>500ml</td>
</tr>
<tr>
<td>Mannitol 10%</td>
<td>500ml</td>
<td>–</td>
</tr>
<tr>
<td>Fresh frozen plasma</td>
<td>–</td>
<td>800ml</td>
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<tr>
<td>Potassium</td>
<td>26mmol</td>
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Myocardial protection was achieved by hypothermia. General moderate hypothermia (26°C) was induced through the extracorporeal circulation by the heat exchanger. Ringer lactate solution (two to four litres) was used to maintain the hypothermic cardiac arrest. This solution, which is normally infused in the extracorporeal circulation, was for these dialysed patients drained off to avoid fluid overload. Surface cooling completed the hypothermic management using isotonic saline solution (four to eight litres) cooled to 4°C.

Dialysis access must be protected; if an arteriovenous fistula is present, the extremity must be well guarded to prevent pressure and occlusion on the operating table, and no blood pressure cuffs or intravenous needles are used in that arm. If a shunt is present the two limbs are perfused with heparinised saline solution. Routine antibiotics were administered with adaptation to renal failure when necessary. Bladder catheterisation was not routinely performed during surgery. Post-operative dialysis was generally not necessary until the second or third post-operative day. Most patients without bleeding problems were heparinised immediately post-operatively in relation to the presence of a prosthetic valve or coronary artery bypass grafts. Therefore dialysis sessions were performed without heparin as we have described previously [5].

Results

Prosthetic valves used in the 11 cases were Starr-Edwards and Bjork-Shiley valves. No porcine heterografts were used. Saphenous vein grafts were utilised for coronary artery bypass surgery. Woven Dacron tube graft with coronary
artery implantation to the graft was performed in the Pezzi-Laubry syndrome.

Weight gain was moderate during the cardiopulmonary bypass (1.100 ± 0.400kg). Mean post-operative bleeding was 1200ml (360–2400ml) which was replaced by packed red cells. Only one patient was re-explored for bleeding. Mean daily infusion was about 300ml of hypertonic glucose. Vasoactive drugs were needed in five patients for a period of one to five days.

There was no operative mortality in this series. Three early post-operative deaths occurred: two patients with bacterial endocarditis died with poor cardiac output and intractable ventricular arrhythmias. Another death was due to an extension of a myocardial infarction after coronary bypass. Follow-up of the 14 survivors from one month to seven years has been obtained: one patient died after six months from hypoglycaemia, another after nine months from recurrent endocarditis; a third died five years after surgery from a cerebrovascular accident. To date 11 patients are surviving from one to 84 months with a mean period of 36 months. Three patients who received coronary artery bypass improved their functional status; two are treated by CAPD, one by haemodialysis. Only one patient with previous endocarditis is surviving five years after open heart surgery with functional class I. This patient received a kidney transplant three years ago. Six patients who had aortic or mitral valve replacement improved one functional class respectively. The patient with Pezzi Laubry syndrome returned to functional class II.

Discussion

Experience with open heart surgery in uraemic patients can be accomplished with acceptable results [4,6,7]. Uncontrolled heart failure, low cardiac output, bacterial endocarditis and coronary artery diseases were recognised as major cardiac complications of long-term dialysis therapy [2]. In this group of patients the incidence of subacute bacterial endocarditis is between 2.7 and 6.6 per cent [9] due to: 1) depression of immunity; 2) presence of an arteriovenous fistula whether infected or not; and 3) transient episodes of bacteriemia, during dialysis. The surgical mortality rate was 30 per cent in a recent review of the literature [10] in 26 cases with subacute bacterial endocarditis compared to a 60 per cent mortality rate with medical treatment.

It has been claimed that accelerated atherogenesis is present in the dialysis population [3]. Exact reasons have not been completely identified: however, hypertension, glucose intolerance, hypertriglyceridaemia, vascular calcifications and hyperparathyroidism obviously contribute to the increased incidence of coronary artery disease. Sudden changes in intravascular volumes and electrolyte composition, effects of anaemia, acidosis, arteriovenous fistula and stressful life situations add to the haemodynamic demands required of an ischaemic myocardium. These factors may make medical control of angina more difficult. Many reports suggest that coronary angiography and coronary artery bypass graft surgery are suitable, with a mortality rate of about 10 per cent in both dialysed and transplanted patients.

A co-ordinated approach to the peri-operative period should ensure good
results. To prevent acidosis, hyperkalaemia and hypervolaemia during surgery, dialysis treatment should be performed just before surgery. Induction and maintenance of anaesthesia can be undertaken routinely. Haemodilution technique seems to decrease the chance of coagulation difficulties in these uraemic patients. Our haemodilution technique using a minimal fluid infusion allows us to decrease weight gain during cardiopulmonary bypass to 1.100kg in dialysis patients compared to 2.6kg in patients with normal kidney function. Vascular access protection has been emphasised by many authors and occasional heparin infusion has been recommended.

Valve replacement can be undertaken using either porcine heterografts or prosthetic valves. The risk of prosthetic infection and the risk of anticoagulation has led some to prefer porcine heterografts. Secondary hyperparathyroidism with high serum calcium and vascular calcification is common in dialysed patients and suggests the use of prosthetic rather than biological grafts despite the fact they need more anticoagulation therapy. For CABG grafts most workers prefer autogenous saphenous grafts for the bypass conduit. When the saphenous vein cannot be utilised the internal mammary artery has been successfully employed.

Post-surgery dialysis therapy is controversial. Some prefer systematically to initiate peritoneal dialysis after surgery to avoid anticoagulation, while others recommend regional heparinisation. In our department CAPD was reintroduced immediately post-operatively, and haemodialysis sessions were performed without heparin 36 to 48 hours after surgery with no bleeding problems.

Reports of the literature summarised together 122 surgical procedures in uraemic patients: 63 (52%) valve replacements, 56 (45%) CABG and three other procedures. The operative mortality rate was 12 per cent (15 patients) and late operative mortality 14 per cent (18 patients). Subacute bacterial endocarditis accounted for most of the early deaths (10 of 15 patients).

In summary, our experience with major cardiac surgical procedures in patients with end-stage renal failure demonstrates their ability to tolerate such operations with acceptable morbidity and mortality. The proper selection of these patients combined with intensive and co-ordinated peri-operative care should ensure similar results in patients undergoing open cardiac procedures. Early surgical intervention in uraemic patients with subacute bacterial endocarditis should be considered, and bypass surgery has been shown to be safe in this population.

References
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8 Chawla R, Gaius P, Lazarus JM et al. Trans ASAIO 1977; 23: 694
Open Discussion

KLINKMANN (Chairman) Thank you Dr Rottembourg for this really very impressive result. It shows us quite clearly how far we have come from the early days of Professor Alwall.

COMTY (Minneapolis) What do you do with your patient post-operatively in terms of anticoagulation and in the coronary artery bypass grafts in terms of using beta-blockers?

ROTTEMBOURG For anticoagulation post-operatively, patients are for one to three weeks on heparin with subcutaneous injections three times per day and after that with oral anticoagulation for long periods.

COMTY Are you continuing with beta blockers in your patients after coronary artery bypass grafts in the absence of angina?

ROTTEMBOURG If hypertension persists then we use beta-blockers.

COMTY I was thinking of their use as an anti-arrhythmic in patients who have good left ventricular function.

ROTTEMBOURG When there is an improvement of the left ventricular function and no other requirement, we stop them.

SCHIEFT (Leiden) Why don't you dialyse patients while they are on the heart machine? It is easy, you don't use anything extra.

ROTTEMBOURG I know that is possible, but we prefer to do it immediately pre-operatively.

SCHIEFT It's easy: they are already heparinised and you can easily do without dialysis after the operation. The anaesthetist can give whatever he wants because you dialyse it out.

ROTTEMBOURG I did not know you worked in a cardiac operating theatre!

SCHIEFT We do. We dialyse our patients during surgery.

ROTTEMBOURG There are many people, many machines and one more I think is not necessary when dialysis can be performed immediately before surgery. We perform dialysis in the morning from seven to 11am and the patient is operated on at 11.30am. Surgeons are unhappy at having too many people in their operating room and I think that it is better to leave them quiet with a normal patient without any additional machine.

KLINKMANN Dr Schieft, do you dialyse during cardiac surgery?
SCHIEFT Routinely.

KLINKMANN And no surgeon chases you out?

SCHIEFT They are quite happy to have us there.

KLINKMANN Alright, you are lucky, you're a lady.

KRAMER (Linz) In many centres haemofiltration is done during the operation to remove excess water and it is very easily done by the pump. Do you think that angioplasty is a good technique in a single vessel stenosis on dialysis patients? I see from your results there are a few patients undergoing cardiac surgery for one vessel disease.

ROTTEMBOURG Of the five patients who received coronary artery bypass two of them received only one saphenous, two of them two, and one of them three grafts. These operations were performed I think in 1976 or 1977. At that time angioplasty was not available in France. I think from now angioplasty could at least be tried on these patients, but you know that those performing angioplasty do not like to have patients with long-standing hypertension because they know perfectly well that the angioplasty is not performed with great success if the patient has been hypertensive for 10 or 15 years. Most of our uraemic patients have long-term hypertension, so I am not sure that angioplasty will be the right treatment, but it could be tried.