Anaesthesia for kidney transplantation

Introduction

In 1954, Joseph Murray performed the first successful renal transplantation on identical twins. Due to improvements in immunosuppressant medication and surgical techniques in the past decades, the organ survival rate has increased significantly. A study comparing kidney recipients, patients on the waiting list and patients on dialysis showed a significant reduction in mortality in the patients that have been transplanted.1 The kidney donor pool has been expanded and even marginal organs are being transplanted, as they provide survival benefit in comparison to dialysis.2,3 The indication for renal transplantation was extended to older patients with worse medical prognosis than before.4 Particularly the recipients in the Eurotransplant Senior Program “old-for-old” require an individualised intra- and postoperative management by the attending anaesthetist.5

Pre-operative assessment

Patients undergoing renal transplant surgery possess several high risk characteristics like cardiovascular diseases and diabetes mellitus, and the need for dialysis. Therefore a thorough pre-operative assessment is crucial for successful intra- and postoperative management. Risk factors like hypertension, cardiovascular disease and diabetes must be considered in these patients with end stage kidney disease.6

The preoperative work-up includes an evaluation of dialysis (How long? How often? When was the last dialysis? Any diuresis left?), past medical history, blood analysis (potassium) and ECG and chest X-ray).

It is necessary to distinguish between living donor and deceased donor transplantation. Patients receiving an organ from a living donor are usually in better clinical shape and, in some cases, kidney transplantation is even performed prior to renal replacement therapy.7 Patients receiving kidneys from deceased donors may have to wait on dialysis for years. Their outcome after transplantation is worse, due to several other complications of end stage renal disease.8 Particularly in these patients, further intervention before surgery is not possible.

Intra-operative management

In a survey conducted in 2002, in over 90% of renal transplant surgery procedures, normal saline was used for hydration in order to avoid hyperkalaemia.9 Recent studies have shown, however, that the use of normal saline leads to a major increase in serum potassium compared with Ringer’s lactate, most likely due to hyperchloraemic acidosis.10 Consequently, the use of Ringer’s lactate is preferred in renal transplant surgery.

Three older studies were able to show a significant benefit with hydration with albumin. In these studies, hydration is combined with several other treatments like administration of mannitol or diuretics, which could lead to a bias in favour of albumin. Due to side effects like anaphylactic reactions and potential infectious contamination, albumin is hardly used in the operation theatre.

Different alternative colloids like gelatine, dextrane and hydroxyethyl starch (HES) have been developed over the last years. For all of these, different adverse events, like impairment of renal function, are described.11 However, recent studies showed that HES with low molecular weight could also be used for hydration in patients with severe volume deficit. When given within the dosage limit, there are no side effects like bleeding complications and dysfunction of the reticuloendothelial system or renal function.12

Another aspect of importance in renal transplant surgery is the use of different types of drugs in order to improve postoperative renal outcome. Best evaluated in this context is the infusion of 200 - 250 ml of mannitol 20% immediately before reperfusion. Three older randomised controlled trials showed a significant reduction in acute renal failure after the operation.

Two major randomised controlled trials did not show any benefit for the administration of furosemide for the treatment of renal failure.13,14 These situations can be compared to the intra-operative setting during transplantation. Although there are no randomised controlled studies investigating the effect of diuretics on the recovery of renal function after transplantation, the use of furosemide in renal transplant surgery seems not to be beneficial.

Dopamine has been administered as therapy for renal failure for years. However, two major meta-analyses showed that dopamine had a detrimental effect on renal function in acute renal failure.15,16 Therefore, the use of dopamine cannot be recommended for renal transplant surgery.

Another important issue in renal transplant surgery is whether to dialyse immediately prior to surgery. One study investigating
this aspect showed no benefit regarding delayed graft function or one-year survival.\textsuperscript{17} In most cases, dialysis prior to surgery is not necessary, but should be considered in patients with extremely elevated serum potassium levels.

The recommendations about haemodynamic monitoring during renal transplant surgery are still unclear. Commonly, no arterial lines are placed and, in some hospitals, a central venous catheter is inserted only in 30\% of the operations.\textsuperscript{18} Further invasive monitoring, like a pulmonary artery catheter, is only used in very special cases. Whether measurement of the central venous pressure (CVP) can be used for volume management is controversial, and not only in kidney recipients. These patients, particularly, show a decrease in CVP after the transplantation, which does not correlate with fluid status.\textsuperscript{19} There are no randomised controlled studies investigating the benefit of CVP monitoring.

In addition to the type of monitoring that is recommended, the amount of fluid that should be administered is unclear. Although previous studies recommend slight overhydration, recent data showed no increase in delayed graft failure with a more restrictive hydration regime (CVP 7 - 9 mmHg).\textsuperscript{20}

During induction, anaesthetist must be aware of an increased risk of reflux due to uraemic neuropathy with reduced intestinal motility in patients with end stage renal disease. However, the most common muscle relaxant used for rapid sequence induction, succinylcholine, might increase the serum potassium levels, which presents a particular problem in patients with uraemic or diabetic neuropathy. If no rapid sequence induction is necessary, atracurium and cis-atracurium should be used. Both are inactivated by Hofmann elimination and hydrolysis by esterases. The safety of atracurium and cis-atracurium in end stage renal disease has been evaluated in different studies showing no prolonged muscle relaxation.\textsuperscript{21} However, the metabolite of atracurium and cis-atracurium is laudanosin, which can cause seizures in higher concentrations is dependent on renal elimination. Even at levels below the toxic limit, its concentration is increased in patients with end stage renal disease. It is recommended to use cis-atracurium, as it is about four times as potent as atracurium, resulting in lower laudanosin plasma levels.\textsuperscript{15}

Another toxic metabolite which should be noted in the context of renal insufficiency is Compound A. It is generated due to a chemical reaction between sevoflurane and the carbon dioxide absorber. There is evidence that Compound A is detrimental to renal function in rats.\textsuperscript{22} In contrast with this, other studies showed no negative effect of sevoflurane on renal function.\textsuperscript{23} Therefore, it can be safely used for renal transplant surgery, as can isoflurane and desflurane.\textsuperscript{24}

Summary
Anesthesia for renal transplant surgery poses a challenge for the attending anaesthetist. Each patient needs an individualised intra- and postoperative anaesthetic regimen, according to the status of the end stage kidney disease and the comorbidities. The type and amount of volume therapy is of particular interest during renal transplant surgery, as it is a knowledge of the potentially nephrotoxic effects of drugs often used during anesthesia. Therefore, the anaesthetic management can influence renal outcome after renal transplant surgery, including graft survival and mortality.

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