Perioperative Fluid Management in Kidney Transplantation: Is Volume Overload Still Mandatory for Graft Function?

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ABSTRACT

Kidney transplantation is now recognized as the treatment of choice for patients with chronic renal failure. Despite the extension of indications to patients suffering severe hypertension, ischemic heart disease, and chronic heart failure, the worldwide results are superb. However, perioperative cardiac complications occur in 6% to 10% of transplanted patients. Aggressive intraoperative volume expansion is still recommended to maximize graft functional recovery (up to 30 mL/kg/h, central venous pressure [CVP] > 15 mm Hg), but patients with preexistent cardiac disease or poor myocardial function are exposed to the risk of fluid overload, acute respiratory failure, and prolonged ventilation. Among the last 90 cases performed at our institution, good functional recovery of the graft was present in 94% of the patients within 2 weeks, despite a much more conservative intraoperative hydration policy (crystalloids 2400 ± 1000 mL, 15 mL/kg/h, CVP 7–9 mm Hg). Graft failure which occurred in 5 patients was significantly correlated only with donor age, while perioperative cardiovascular complications had been present in 9 cases (10%) who were coronary artery disease patients (55%). Age above 50 years was the only significant risk factor. Supranormal volume loading is probably not always warranted in kidney transplantation.

EMERGING as a relevant therapeutic option for end-stage renal disease (ESRD) since the late 1960s, kidney transplantation is now recognized as the treatment of choice for patients with chronic renal failure.1,2 In the last few years, a multidisciplinary approach, together with advances in technical skills of surgeons and anesthesiologists as well as significant improvements in immunosuppressive drug therapy, have led to ever-expanding selection criteria, making patients eligible for transplantation who would have been excluded a few years ago. When properly evaluated and aggressively managed, these subjects show a perioperative mortality below 2% to 3%.3 Despite the extension of the indications, the worldwide results are superb, with high rates of long-term survival, extremely good quality of life, and acceptable costs of chronic immunosuppressive therapy.

In many series, diabetes mellitus (DM) is the most important cause of renal failure (20%–30%), followed by glomerulonephritis (20%), and chronic tubulointerstitial disease, chronic pyelonephritis, hereditary renal disease, and arterial disease.2 Among the major complications associated with ESRD are cardiovascular diseases. ESRD patients are prone to accelerated atherosclerosis: hypertension occurs in more than 80% of subjects on dialysis and ischemic heart disease occurs in more than 25% of cases in some series. The incidence of acute myocardial infarction or acute heart failure is close to 10% per year.2 In a recent survey, perioperative cardiac complications were reported to be 6%.3 Preexistent cardiac disease and age over 50 years were the major risk factors for cardiac complications after kidney transplant surgery, while DM was found to be a significant risk factor only for perioperative acute myocardial infarction. Definition of preoperative history and risk factors is mandatory to document preexistent cardiorespiratory complications or rule out cardiac risk factors as well as to define perioperative strategies to reduce or avoid perioperative cardiac morbidity: acute myocardial infarction, congestive heart failure, cardiac arrhythmias, and cardiac death. Patients with symptomatic heart disease or
those at high risk for coronary artery disease include those with at least two of the following factors: previous history, DM, age >50 years, heavy smoking, arterial hypertension, and obesity. They should undergo noninvasive evaluation by two-dimensional echocardiogram immediately after dialysis to increase sensitivity. In cases of reduced ejection fraction (below 40%) or regional changes in contractility, we perform exercise or pharmacological stress tests. Ejection fractions below 35% to 40% or reversible defects during stress tests in high-risk patients mandate aggressive treatment by coronary artery bypass graft or PTCA as indicated to significantly reduce both cardiac morbidity and mortality, which are 1% and 0% in treated vs 43% and 31% in nontreated patients, respectively. Properly timed preoperative evaluation and aggressive management must be implemented to avoid unacceptable risks of perioperative cardiac events.

It has long been known that the most important intraoperative measure to improve immediate graft function is to maintain an adequate intravascular volume. As a matter of fact, early graft malfunction has been associated with decreased graft survival and increased recipient complications. In this setting, one of the specific tasks of the anesthesiologist during the procedure is the optimization of the hemodynamic status before kidney reperfusion. Carlier et al were able to demonstrate that maximal hydration during anesthetics (up to 100 mL/kg normal saline, 30 mL/kg/h) and elevated right heart pressures (central venous pressure [CVP] 10–17 mm Hg; diastolic pulmonary pressure [PAPD] above 20 mm Hg) were associated with improved early graft function (acute tubular necrosis [ATN] 6% if PAPD > 15 mm Hg, vs ATN 36% when PAPD < 15 mm Hg). However, while attaining maximal hydration, patients with preexistent cardiac disease or poor myocardial function were at overt risk of fluid overload, acute pulmonary edema, acute respiratory failure, and prolonged intubation. An aggressive intraoperative volume expansion, by keeping CVP between 10 and 15 mm Hg, is still uniformly recommended in the anesthesiological management to avoid acute tubular necrosis secondary to inadequate intraoperative hydration. Willms et al and Dawidson et al found that a fluid regime including 0.8 to 1.6 mL/kg 5% albumin was able to improve the overall outcome of the procedure as evidenced by graft survival; urine volume, and early graft function.

METHODS

The patient deserves a dedicated intraoperative hemodynamic monitoring which should include EKG (DIII, V5) with an automated ST analysis for myocardial ischemia, arterial blood pressure (invasive or noninvasive), CVP, urine output, core temperature, pulse oximetry, and tidal CO2. In cases of known severe cardiac dysfunction or difficult differential diagnosis of acute perioperative hemodynamic impairment (mainly critical hypotension), more sophisticated tools must monitor cardiac output, filling pressures and/or preload parameters (Swan Ganz catheter, PiCCO, transesophageal echocardiography). In our opinion, and at variance with some other anesthetists’ suggestion, invasive monitoring of arterial blood pressure should be obtained whenever possible, since these patients are at the highest risk for cardiac complications during induction of the anesthesia and at the time of reperfusion. The arterial line must be placed opposite to the site of the arterovenous fistula. It allows continuous arterial pressure monitoring and sampling of values for arterial blood gas and/or blood chemistry (mainly potassium, glucose, hematocrit/hemoglobin). Systolic blood pressure (SBP) variations during mechanical ventilation have also been used as indirect measures of the adequacy of intravascular filling state. Lastly but not least, systolic arterial blood pressures above 140 mm Hg and diastolic arterial pressure between 85 and 110 mm Hg have been proposed as targeted values to maximize early graft function. The use of pressors (mainly dopamine) to support volume therapy has been strongly recommended when fluid load alone did not reach the goals. Central venous cannulation and CVP monitoring are uniformly recommended for all patients to gauge and monitor the intravascular volume status. Despite the well-known bias introduced by the use of right heart pressures (mainly CVP) to estimate preload status and to gauge intraoperative fluid balance, no attempt has been made so far to change the time-honored CVP monitoring with a more precise, minimally invasive (but much more expensive) system able to give more precise volumetric measures of the preload (such as the PiCCO system, Pulsion). As already mentioned, to achieve normal or “supernormal” intravascular volume to avoid ATN, crystalloids (mainly normal saline), artificial colloids, and albumin have been used at substantially high volumes (up to 30 mL/kg/h). In cases of low hematocrit, some authors have advocated the use of packed red cells to increase the hematocrit above 25%. Among the artificial colloids, gelatin is usually preferred to hydroxyethyl starch (HES) derivatives because of a demonstrated renal toxicity. However, the new HES derivative with lower molecular weight and lower degree of substitution (Voluven 130/0.4, Kabi Fresenius) has shown a more favorable pharmacokinetic/dynamic profile, with little or no interference with kidney function. Despite the recommended large fluid load during kidney transplantation, our intraoperative volume loading policy is much more conservative. Excessive dehydration during pretransplant dialysis is usually avoided, keeping acute weight loss during pretransplant dialysis within 1 kg bw.

We always perform the procedure under general anesthesia induced with propofol11 and maintained with fentanyl, isoflurane, or sevoflurane. Remifentanyl is sometimes used. Atracurium or cysatracurium in refracted doses is used for muscle relaxation. Monitoring includes EKG (DIII, V5, ST automated analysis), invasive arterial blood pressure (arterial cannulation before induction of anesthesia in cardiac patients), CVP (mainly via right internal jugular vein catheterization, performed immediately after induction), SaO2/ETCO2, core temperature, and urine output. To keep core temperature within normal limits, we use both warming blankets (Bair Hugger, Augustin Medical) and fluid warmer. Swan Ganz catheter is seldom used (electively positioned in complex cases or acutely passed for severe perioperative hemodynamic impairment, when conventional monitoring is unable to guide proper and successful cardiovascular manipulation). If needed, arterial blood is drawn for automated profiles including acid base equilibrium, blood gases, electrolytes, glucose and hematocrit (the latter kept above 25%–27%). Pharmacological manipulation includes infusion of 125 mL mannitol (20%) and administration of furosemide (500 mg) during the vascular anastomoses. Dopamine has never been used at the so-called “renal dose,” but sometimes as a pressor or an inotropic agent in cases of critical hypotension or
Acute heart failure. Intraoperative volume management includes moderate fluid load (crystalloids 2400 ± 1000 mL, mainly normal saline, 15 mL/kg/h, range, 8–25 mL) aiming at CVP 7 to 9 mm Hg (range, 5–10 mm Hg) and MAP above 85 mm Hg (range, 70–115 mm Hg).

RESULTS

Among the last 90 cases (January 2003 to May 2004, mean age, 48 ± 12 years), none of the patients received albumin, packed red cells, or blood products. Synthetic colloids (3% gelatin) were used in 10 patients. Good functional recovery of the graft was present in 94% of the patients, while the 6-month survival rate was 97.7%. Coronary artery disease (CAD) was present in 9 patients (10%). Perioperative cardiovascular complications present in 9 cases were more common in CAD patients (55%), age above 50 years being the only significant risk factor. Graft failure was recorded in 5 patients (6%), which was only significantly correlated with donor age. Contrary to already published data, intraoperative fluid load, CVP, and warm (always below 50 minutes) or cold (always below 16 hours) graft ischemia time were not significantly different among grafts that did versus did not show good outcomes (De Gasperi, unpublished data).

DISCUSSION

An accurate, multidisciplinary preoperative evaluation allows a rational perioperative anesthesiological approach to the ESRD patient who is a transplant candidate.1−4 The entire process should aim at a safe (“proper evaluation”) and adequate (“goal directed”) medical management of an “already known” patient, as opposed to a “last minute” evaluation, with the whole scenario of possible negative consequences. The results achieved in our series, keeping preload indicators at levels lower than these reported by others,2,5−8 but perhaps safer for a significant number of ESRD patients, lead us to conclude that supranormal volume loading is probably not always warranted. Volumetric estimates of preload status are now easily available, but expensive, and probably unlikely to be cost effective in this specific setting for routine cases. Prospective studies targeting central venous O₂ saturation during the procedure to improve intravascular volume optimization may change at least in part the methods to gauge the intraoperative volume status in this setting.

REFERENCES