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Kidney Transplantation: Anesthetic Consideration

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Abstract: *Renal transplantation is the preferred treatment for end stage renal disease. Renal transplant anesthesia requires a thorough understanding of the metabolic and systemic abnormalities in end stage renal disease, familiarity with transplant medicine and expertise in managing and optimizing these patients for the best possible outcome. Also, the associated co-morbid conditions increase the complexity of anesthesia, pain management and perioperative morbidity and mortality. Hence, a good perioperative management of the patients includes a multidisciplinary collaboration with-planned anesthetic strategies.*

Keywords*: Renal transplantation, Anesthesia management, Recipient, Cadaver donor, Living donor.*

I. Introduction

The first kidney transplantations were performed in the 1950's; however renal transplantation did not become widespread until the development of effective immunosuppression in the 1960's. Since then, kidney transplantation has become the most common organ transplant surgery performed. Current 3 years post transplant survival for adults is 96% for living donor kidney transplants and 90% for deceased donor transplants[1]. Paired kidney donations consist of two incompatible donor – recipient pairs exchanging kidneys to create two compatible pairs.

Indications for Kidney Transplantation

Kidney transplantation is indicated in patients with chronic renal failure or more appropriately chronic kidney disease (CKD) refers to a decline in the glomerular filtration rate (GFR) caused by a variety of diseases such as diabetes mellritus (40%), hypertension (27%), chronic glomerulonephritis (13%), cystic kidney disease (3.5%), interstitial nephritis (4%) and other diseases such as obstructive uropathy, lupus nephritis and human immune deficiency virus[2]. Patients with GRF below 15 ml/min/1.73m^2 (often said to be have end stage renal disease) are dependent on dialysis for survival until they receive a successful transplant.

Clinical problems relevant to anesthesia for renal transplantation-

1. Cardiovascular disease: The two main cardio vascular effects of CRF are arterial hypertension[3] and ischemia heart disease. Patients receiving antihypertensive or antianginal treatment should receive their regular therapy as part of premedication.
2. Anemia: Normochromic, normocytic anemia of complex origin usually due to erythropoiesis, decreased RBC life span[4]. At a Hb concentration of 6 to 8 g/100ml, the oxygen carrying capacity of the blood is about 50% normal. Anemia should be corrected before surgery.
3. Respiratory system: Pulmonary congestion and edema and pleuritis often are seen with a resultant hypoxemia and hypocapnia.
4. Acid-Base status and electrolyte imbalance: Patients with renal failure have an impaired ability to excrete water, electrolytes and free acids. The presence of a metabolic acidosis with its associated electrolyte disturbances (hypothermia, hypochloremia, and hyperkalemia) may cause problems with respect to the adequacy of reversal of residual neuromuscular blockade at the end of anesthesia.
5. Coagulation: Platelet dysfunction, decreased level of platelet factor III resulting in poor adhesiveness and thrombocytopenia shows no alteration in prothrombin or partial thromboplastin time, but the bleeding time is prolonged. Platelet transfusion and cryoprecipitate should be given to correct uremic coagulopathy.
6. Central nervous system: Peripheral neuropathies associated with postural hypotension and disequilibrium syndrome may be present with uremia.
7. Endocrine system: Diabetic nephropathy and uremic osteodystrophy may be present in these patients[5].
8. Gastrointestinal tract: Anorexia, nausea, vomiting, delayed gastric emptying and ascities. Patients are benefited with histamin H_2 receptor antagonist as part of premedication.
9. Immune system: Due to immunosuppresersant drugs, sepsis remains a major cause of morbidity and mortality strict aseptic technique should be used for all invasive procedures.

10. Problems of dialysis: Main sequel are excessive or persistent heparinization, abnormal fluid shifts, β_2 microglobulinemia, dialysis disequilibrium syndrome, hepatitis, HIV, leucopenia and hypocomplementemia[6].

Guidelines: Donor Evaluation

Before donation, the live donor must receive a complete medical and psychosocial evaluation, receive appropriate informed consent and be capable of understanding the information presented in that process to make a voluntary decision. All donors should have standard tests performed to ensure donor safety.

Hypertension-Patients with BP > 140/90 mm of Hg by ABPM are generally not acceptable as donors[7].

Obesity- Patients with body mass index >35kg/m^2 should be discouraged from donating , especially when other co-morbid conditions are present.

Dyslipidemia – Dyslipidemia should be included along with other risk factors in donor risk assessment, but dyslipidemia alone does not exclude kidney donation.

Acceptable donor renal function- GFR <80ml/min generally precludes donation. DTPA renal scan for GFR and renal angiography for the study of both kidneys ,urinary bladder and renal vessels are done in all cases.

Urinalysis for protein- A 24 hour urine protein >30mg is a contraindication to donation

Urinalysis for blood- Patients with persistent microscopic hematuria should not be considered for kidney donation. Diabetes- Individual with a history of diabetes or blood sugar (F) >126mg/dl or (PP) 200mg/dl should not donate. Stone disease- An asymptomatic potential donor with history of single stone may donate if no hypercalcuria/cystinuria or no UTI. Malignancy- Usually excluded from live kidney donor.

Urinary tract infection- Donor urine should be sterile before donation.

Live unrelated donors- No restriction of live kidney donation based on the absence of an HLA match.

Determination of cardiovascular risk- Major/intermediate predictors of CVS risk as per AHA standards are contraindicated for donation. Minor predictors like old age, abnormal ECG , uncontrolled hypertension warrant individual consideration.

Assessment of pulmonary issues- Increased risk of post operative pulmonary complication is associated with FEV 1 <70% or FVC <70% of predicted or ratio of FEV1/FVC <65%.

Smoking cessation and alcohol abstinence- Smoking/alcohol should be avoided for a minimum of 4 weeks before donation to decrease risk of postoperative morbidity.

Donor kidney- The number of living donors has exceeded that of cadaver donors because of low morbidity after kidney donation and availability of minimally invasive approach like laproscopic donor nephrectomy and the recent robotic hand assisted donor nephrectomy. Living related donor transplant are performed electively with donor and recipient anesthetized simultaneously but in separate rooms. The traditional approach is a subcoastal lateral incision. The left kidney is preferred because of better surgical exposure and longer vascular supply. Position is lateral with table flexed and kidney rest elevated. One or two large peripheral venous lines usually suffice and invasive monitoring is not required. To maintain good diuresis, fluid administration is generous (10-20 ml/kg/hr) using isotonic crystalloids intra operatively. Loop diuretics and/or mannitol may be used to promote diuresis from the grafted kidney. Mannitol improves renal blood flow, acts as a free radical scavenger and reduces the incidence of impaired renal function immediately after transplant. Postoperative pain is usually mild to moderate and managed in most cases using intravenous opioids. Deceased donor kidneys are preserved using hypothermia and pharmacologic inhibition to slow down metabolic processes. Cold ischemia time should be kept below 36-40 hours in case of cadaveric donors often which the incidence of delay graft function increases significantly. Kidney from living donor may be flushed with preservative solution or iced Ringer's locate solution containing heparin and mannitol. The cold ischemia time in a living donor should be restricted to 20-30 minutes while the warm ischemia time should not exceed 3-5 minutes.

Peri-operative management of Recipient patient :

Influence of renal disease on pharmacokinetics and pharmacodynamics of drugs used during anesthesia.

Many important changes occur in the uptake, disposition, metabolism and excretion of drugs given to patients with chronic renal failure, as follows:

1. Altered absorption of oral drugs due to gastric status.
2. Altered apparent volumes of distribution
3. Altered plasma protein binding and free drug fraction.
4. Altered drug and xenobiotic metabolism.
5. Altered drug elimination.

Preoperative assessment

Preoperative assessment should lead to optimization of any persistent serious complication, such as congestive heart failure, ECG abnormalities resulting from myocardial ischemia and autonomic dysfunction in patients with diabetes mellitus. Patients maintained on hemodialysis usually undergo a dialysis session at some point during the 24 to 36 hour period before transplantation. Predialysis and postdialysis weight and electrolyte status should be recorded.Functional shunts or fistula should be protected carefully during surgery with sphygmomanometer cuff placed on other arm. Immunosuppressive therapy (thymoglobulin) may be instituted during the perioperative period and its side-effects knowledge is required.

Premedicant drugs

Anticholinergic drugs- Atropine and glycopyrolate can be used as single dose.

Antacids and prokinetic drugs- H_2-histamine receptor antagonists such as ranitidine and proton pump inhibitors such as omeprazole can be used safely. Metoclopromide is eliminated via kidney unchanged. Significant side effects may occur after its use hence should be avoided[8].

Benzodiazepines- Diazepam action is prolonged in chronic renal failure, however midazolam given slowly can be used[9,10].

Anesthesia for kidney transplant:

General anesthesia with endotracheal intubation is the preferred anesthetic method for kidney transplantation. The goals of anesthesia are to facilitate an adequate depth of anesthesia while maintaining hemodynamic stability and to provide appropriate muscle relaxation to facilitate surgical conditions. Patients with ESRD are considered a risk for aspiration of gastric contents secondary to the presence of uremic gastropathy and other conditions, such as obesity and diabetes. An oral nonparticulate antacid and intravenous administration of an H_2 blocker, such as ranitidine, should be given before induction of anesthesia. A rapid sequence induction of anesthesia with continous cricoid pressure is the preferred method of induction for general anesthesia. Succinylcholine can be used safely in standard doses in patients with ESRD when potassium levels are within normal limits (usually <5.5mEq/L). A modified rapid sequence induction with rocuronium 0.8-1.2mg/kg intravenously is an appropriate substitute for succinylcholine when hyperkalemia or other contraindication to succinylcholine exists[11].

The hemodynamic response to laryngoscopy can be attenuated with supplemental fentanyl, esmolol, lidocaine or nitroglycerine titrated to effect. Following the stress of tracheal intubation, kidney transplant patients may develop hypotension before surgical incision, especially in patients who have been rendered hypovolemic from recent dialysis or in patients receiving rennin-angiotensin blocking drugs.

Intraoperative monitoring consist of ECG, SpO_2, central venous pressure and intra-arterial blood pressure monitoring. Pulmonary artery catheter or transesophageal echocardiographic monitoring may be considered in patients with advanced CAD and pulmonary hypertension with ventricular dysfunction. The insertion of a central line provides reliable venous access for intra vascular fluid resuscitation and transfusion and access for administration of immunosuppression drugs and vasoactive infusions. Large bore venous access is necessary for appropriate intravascular volume administration in the perioperative period.

Maintenance of anesthesia is performed using a combination of intravenous and inhaled anesthetics. Isoflurane and desflurane are safe anesthetic agents. Analgesia during intraoperative period can be provided with fentanyl, sufentanil and remifentanil, because their pharmacokinetics and pharmacodynamics are not affected by renal insufficiency.

Appropriate neuromuscular blockade during kidney transplantation is important for optimizing surgical conditions. Atracurium and cisatracurium are the muscle relaxant of choice in patients with ESRD. Both vecuronium and rocuronium have prolonged duration of action in renal failure patients.

The surgical procedure involves placement of the renal allograft usually in the right inguinal region. The external iliac vein and artery are identified and mobilized. Heparin may be administered before clamping of the vessels. The external iliac vein is clamped first and the renal vein anastomosis is performed. During the anastomosis of the renal vessels, expansion of intravascular volume with normal saline should be initiated. Furosemide and mannitol are administered before reperfusion to stimulate diuresis. After completion of the vascular anastomoses, the donor graft ureter is implanted in to recipient bladder which is filled with antibiotic saline irrigation solution.

At the end of the surgery, the patient is reversed with neostigmine and glycopyrolate. Extubation of the trachea should occur after the patient demonstrates the ability to protect the airway.After extubation of the trachea, the kidney transplant recipient requires carefull monitoring in the post anesthesia care unit. Close monitoring of the urine output in the initial post operative period is important. The major post operative anesthetic complications are vomiting and pulmonary aspiration; cardiac arrhythmias, which can lead to cardiac arrest; pulmonary edema; hypotension and hypertension; and delayed respiratory depression[12].

II. Conclusion

ESRD and kidney transplantation patients present significant challenges, for the anesthesiologist, in the perioperative period. The optimal approach to anesthetic delivery is to develop an anesthetic plan tailored to the patients specific co-morbidities. Over all optimization of the patients other commodities in the preoperative period, close intraoperative monitoring and optimization of fluid status and hemodynamics as well as appropriate use of anesthetic agents are key to kidney transplantation success.

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