Renal Disease and Anesthesia

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Introduction

Normal renal function is important for the excretion of anesthetics and medications, maintaining fluid and acid-base balance, and regulating hemoglobin levels in the perioperative period.

Anatomy

Kidneys are located in the posterior abdominal wall, with the 11th and 12th ribs and diaphragm placed posteriorly. It is 10 cm in length, 5 cm in width, and 3 cm in thickness.

Functions of the kidney

1. Regulation of ions in the blood: Sodium, Potassium, Calcium, Chloride, Phosphate.
2. Regulation of blood volume: adjust the volume of blood or eliminate water in the urine.
3. Regulation of blood pH: regulate by excreting a variable amount of Hydrogen ions in the urine, conserving bicarbonate HCO3 ions.
4. Production of hormones:
   - Calcitriol: calcium hemostasis.
   - Erythropoietin: RBC production.
   - Renin: blood pressure control.
5. Excretion of Waste:
   - Urea and creatinine.
   - Ammonia and amino acid.
   - Drugs.

Causes of renal failure

1) Diabetes Mellitus 25%
2) Glomerulonephritis 14%
3) Hypertension 8%
4) Polycystic kidney disease 6%
5) Pyelonephritis 6%
6) Renal vascular disease 6%
7) Others 17%
8) Uncertain 15%

Systemic effects of renal failure

1) Cardiovascular system:
    - Left ventricular hypertrophy
    - Atherosclerosis
    - Hypertension
2) Respiratory system: Pulmonary edema
3) Metabolic acidosis
4) Coagulopathy
5) Autonomic neuropathy
6) Fluid and electrolyte:
    - Volume overload
    - Hyperkalemia

Anesthetic considerations

I. Pre-operative Assessment:

- Routine anesthetic assessment along with special attention to renal functions is made.
- Hypertension and ischemic heart disease are commonly seen in chronic renal failure.

- Proteinuria and hypoalbuminemia predispose to edema.
- Urinalysis is a cheap, readily available, and informative laboratory test.
- A complete blood count may reveal anemia, other causes of the anemia include excessive hematuria, and reduced production of erythropoietin by failing kidneys.
- Chest X-ray and ECG may be required.

Summary of pre-operative assessment:

Patients should be optimized in the preoperative period, hypertension should be managed with anti-hypertensives, antibiotic coverage for urinary infections. Routine transfusion is not recommended in chronic kidney disease and may predispose to CHF. Electrolytes should be corrected appropriately and dialysis may be needed in severe renal failure. Pre-medications may be necessary and antacids prophylaxis may be considered.

II. Intra-operative:

- For open or laparoscopic renal surgery, general anesthesia with positive pressure ventilation using muscle relaxation is recommended.
- Rapid sequence intubation is preferred in patients with chronic renal failure.
- Induction of anesthesia may be achieved with intravenous and inhalational agents. Maintenance of anesthesia is achieved with inhalational agents. The induction agent of choice in renal disease is Propofol as it is metabolized by the liver and its excretion is not renal dependent.
- Atracurium is the preferred muscle relaxant as it is metabolized by Hoffman degradation.

- A large-bore intravenous line is required as there may be a sudden risk of bleeding. A limb with an arteriovenous fistula must not be used for intravenous infusions.

III. Monitoring:

Routine standard monitoring is a must. Patients with end-stage disease may require central venous pressure monitored fluid administration. Temperature monitoring is required as renal surgery may take many hours. Warm intravenous fluids and a warming blanket may be used.

IV. Fluid therapy:

Patients may be dehydrated as they are given bowel preparation and may be on dialysis, particularly in old age individuals. Appropriate fluid resuscitation to avoid sudden hypotension at induction with crystalloid fluid aiming for urine output should be 0.5-1 ml/kg/h is required in patients with signs and symptoms of dehydration.

V. Post-operative pain relief:

There can be significant pain, especially in an open approach to kidneys. Multimodal analgesia is required for early mobilization and to reduce the incidence of postoperative pulmonary complications. Epidural analgesia should be used unless contraindicated. Regional analgesia is contraindicated in presence of coagulopathy, thrombocytopenia, anticoagulation, or recent hemodialysis. Fentanyl and other short-acting opioids are useful as they are largely metabolized in the liver. Non-steroidal anti-inflammatory drugs are contraindicated because

of their nephrotoxic potential. Paracetamol is a safe drug and is a good adjuvant analgesic.