The prevalence of diabetes mellitus is steadily increasing throughout the world and in India; the prevalence of diabetes varies from 15% to 20% of the adult population. The age of onset of diabetes is also coming down in India. Inevitably, more and more number of diabetic patients require surgery and hence anesthesia. Perioperative glycemic control and end-organ effects of diabetes influence the surgical outcome and prognosis of the patient. By proper pre-anesthetic evaluation and risk assessment, good anesthetic techniques, meticulous glycemic control and efficient postoperative management, anesthesia can be made safe in diabetic patients. Perioperative management of diabetic patients can be classified into pre, intra and postoperative management.

**PREOPERATIVE MANAGEMENT**

Preoperative management includes detailed evaluation of the end-organ damage, airway and the level of glycemic control, and decision should be made on the type of surgery and choice of anesthesia.

The major risk factors for diabetic patients undergoing surgery are cardiovascular dysfunction, renal insufficiency, joint collagen tissue abnormalities, neuropathies, poor wound healing, postoperative infection, decreased lung volume, decreased lung diffusing capacity, etc.

**Preoperative Evaluation**

The aim of preoperative assessment is to determine the extent of the end-organ damage due to diabetes and to optimize the physiological status of the patient. The type of the disease and the antihypoglycemic agents and other medications for associated diseases should be assessed in detail. Investigations should include blood glucose levels (fasting and postprandial), HbA1c (for long-term control), urine proteins and ketones, serum electrolytes, renal function tests, electrocardiogram (ECG), chest roentgenogram, etc. Complications associated with diabetes should be assessed as mentioned below.

**Cardiovascular Dysfunction**

Diabetic men are four times more prone to and women are five times more prone to develop coronary artery disease. It is not only coronary artery disease but they are also more prone to develop hypertension, cardiomyopathy, heart failure and cerebrovascular accident. Some patients may suffer from myocardial infarction without typical symptoms, i.e. silent ischemia resulting from autonomic neuropathy. In patients with myocardial ischemia, surgical outcome is poor even if the procedure is coronary artery bypass graft or angioplasty, with an unacceptable risk benefit ratio. In case of surgeries like renal transplantation for end-stage diabetic nephropathies or any other elective surgeries, preoperative screening and appropriate coronary revascularization improves surgical outcome.

Cardiovascular function assessment is most important in preoperative examination of diabetic patients. The examiner should ask about any history of breathlessness on exertion, palpitations, pedal edema, chest pain, syncope, paroxysmal nocturnal dyspnea, etc. The treatment history is very important as the patient might be taking antiplatelet or anticoagulant drugs, which should be stopped at least 1 week before surgery. Also, patient might have undergone thrombolysis or other revascularization procedures recently. The clinical examination should include jugular venous pulse, liver enlargement, apexshift, crepitations or any other relevant auscultatory findings. This clinical assessment should be complimented with relevant investigations like ECG, echocardiogram, etc. In ECG, we should look for ischemic changes or previous myocardial infarction. Echocardiogram and treadmill test should be done only if required. Heart failure should be improved before surgery.

**Autonomic Neuropathy**

Diabetic patients will develop distal symmetrical sensory or sensory motor polyneuropathy with variable degree of autonomic involvement. Patients with diabetic autonomic neuropathy are at increased risk of:

- Gastroparesis and consequent aspiration during induction and postoperative period
- Intraoperative and postoperative cardiorespiratory arrest
- Exaggerated pressor response to tracheal intubation
- Profound hypotension at induction
- Bradycardia, hypotension, cardiopulmonary arrest during anesthesia
- Predisposes to intraoperative hypothermia
- Impaired response to hyperventilation or hypoxia
- Increased risk of postoperative urinary retention and hypoxic episodes.

Autonomic neuropathy undermines the ability of the heart to compensate for the stress during surgery. Diabetic autonomic neuropathy develops eventually in up to 50% of the patients and it mainly affects cardiovascular and gastrointestinal system. The clinical signs include orthostatic hypotension, painless myocardial ischemia, lack of heart rate variability, reduced heart rate response to atropine and propanolol, resting tachycardia, early satriety, neurogenic bladder, lack of sweating and impotence.

**Autonomic neuropathy can be assessed by**

- Heart rate response to deep breathing, standing and Valsalva maneuver: In case of heart rate response to deep breathing at a rate of 16 breaths/minute, the difference greater than or equal
Section 5

Plasma sodium concentration decreases

Altered consciousness:
• Vascular insufficiency resulting in local tissue ischemia, enhancing the growth of microaerophilic and anaerobic organisms.

• Altered leukocyte function including inadequate granulocyte production, decreased chemotaxis and impaired adherence to vascular endothelium.

• Impaired phagocytic activity of granulocytes because NADPH is diverted from superoxide production to polyol pathway.

• Vascular insufficiency resulting in local tissue ischemia, enhancing the growth of microaerophilic and anaerobic organisms.

Postoperative Infection

Diabetic patient experiences more infections in clean wounds than nondiabetic patients (rate of wound infection in clean wounds in diabetic patients was 10.7% while in nondiabetic patients was 1.8%). Infections account for two-thirds of postoperative complications and 20% of perioperative death. Factors contributing to increased infection rate in diabetic patients are:

- Altered leukocyte function including inadequate granulocyte production, decreased chemotaxis and impaired adherence to vascular endothelium.

- Impaired phagocytic activity of granulocytes because NADPH is diverted from superoxide production to polyol pathway.

- Vascular insufficiency resulting in local tissue ischemia, enhancing the growth of microaerophilic and anaerobic organisms.

- Reduced intracellular killing of pneumococci and staphylococci.

Tight glycemic control and judicious use of antibiotics reduce the rate of postoperative wound infection.

Metabolic Decompensation

Many of the diabetic patients requiring emergency surgery may have significant metabolic decompensation including ketoacidosis. There would not be enough time for stabilizing patients, but even few golden hours may be sufficient for the correction of life-threatening metabolic abnormalities. The chances of intraoperative cardiac arrhythmias and hypotension can be avoided if intravascular volume depletion and hypokalemia are at least partially treated.

The metabolic challenges during surgery are as follows:

- Stress response with catabolic hormone production: Stress response leads to the secretion of catecholamines, cortisol, growth hormone and glucagon. These hormones have got a hyperglycemic effect and hence require increased dose of insulin during perioperative period.

- Starvation: Both preoperative and postoperative

- Altered consciousness: Mask the symptoms of hypoglycemia and ketoacidosis. Hence, close blood sugar monitoring and testing for ketones in urine is required.

- Circulatory disturbances associated with surgery may alter the absorption of subcutaneous insulin.

- Immobilization

- Electrolyte imbalance: Plasma sodium concentration decreases by about 1.6 MEq/L for every 100 mg/dL increase in plasma glucose above normal. Hypokalemia especially in case of diabetic ketoacidosis requires aggressive replacement therapy. Hypophosphatemia due to tissue catabolism, impaired cellular uptake and increased urinary loss may lead to significant muscular weakness and organ dysfunction.

Type of Surgery and Choice of Anesthesia

In case of a minor surgery, patients are not expected to starve for long duration. Therefore, blood sugar homeostasis is not affected much. But in case of a major surgery, starvation may be required for prolonged period depending upon the procedure and hence aggressive blood sugar monitoring and management is required.

General Anesthesia or Regional Anesthesia

There are no specific guidelines for type of anesthesia, but is decided by the type of surgery and the patient’s preference. Regional anesthesia is preferred for some procedures in diabetic patients especially cataract surgery. But it should be kept in mind that anesthetic requirements are lower and the risk of nerve injury is higher in diabetic patients. Adding adrenaline to anesthetic solution increases risk of ischemia and edematous nerve injury. Regional anesthesia avoids starvation (before and after surgery), avoids hormonal and metabolic changes that occur during general anesthesia and facilitates early mobilization. Thus, regional anesthesia facilitates minimal disruption of the normal daily routine of diet and treatment for diabetic patients. But there is risk of profound hypotension, infection and vascular damage, epidural abscess, etc.

Perioperative Blood Sugar Management

All diabetic medications should be continued until the night before surgery except chlorpropamide and long-acting insulin. Long-acting insulin should be substituted with short/intermediate-acting insulin. Tight control of blood sugar should be established before surgery. The main concern is to avoid harmful hypoglycemia.
Anesthesia in Diabetic Patients

But with the availability of more accurate and easy to use glucose monitors, permissive hyperglycemia is not acceptable nowadays. Tight glyemic control has been found to reduce the mortality and also decreases the incidence of multiorgan failure, sepsisemia, acute renal failure and polynueopathy.

It is important to give carbohydrate source such as IV glucose solution throughout the period of perioperative starvation. It can be given as glucose and insulin infusion running separately or infusion of glucose mixed with insulin. Combined glucose-insulin-potassium solutions (GIK system in the Alberti-Thomson regime or WATTS regimen) have the advantage of inherent safety. Fifty percent glucose solution with 0.25 or 0.5 units/mL of insulin can deliver glucose and insulin equivalent to conventional systems using 10% glucose. This can avoid the administration of large volume of free water. The disadvantage is hypertonic glucose solution need to be given into central vein, which may not be practical always.

Separate infusion of glucose and insulin may provide better glycemic control and found to be more convenient for nursing staff. But if the nursing staffs are not vigilant enough, one infusion may be inadvertently stopped while the other infusion continued, which may lead to disastrous consequences.

INTRAOPERATIVE MANAGEMENT

The aim of intraoperative management is to provide adequate anesthesia, proper positioning and to avoid hypoglycemia, hyperglycemia, ketoacidosis and electrolyte disturbances. It is important to time diabetic patients as first in the operating list, thus shortening the starvation period. Positioning of the patient is also very important to avoid pressure sores and it should be done gradually to avoid sudden drop in blood pressure. Careful titration of inducing agents should be done with adequate preloading to avoid hypotension due to autonomic neuropathy. There are no contraindications to standard anesthetic induction or inhalational agents. Rapid induction with cricoid pressure should be done if laryngoscopy is suspected. A nasogastric tube can be positioned and aspiration should be done if required. Anticipate difficulty in intubation and back up of laryngeal mask airway, proper blades and endotracheal tubes, tracheostomy facility and expert help should be ensured. Intravenous induction agents may cause hypotension, which is worsened in diabetic patients with autonomic neuropathy. Adequate preloading, reducing the dose of induction agents and slow injection will reduce hypotension.

Dehydration should be avoided; normal saline can be used as maintenance fluid. Dextrose containing fluids and ringer lactate are better avoided. Blood sugar should be maintained with insulin-glucose infusion as explained above. Blood sugar should be monitored every hour, also as in any other case SpO₂, blood pressure, ECG, end tidal carbon dioxide, urine output and temperature should be monitored. Continuous arterial blood pressure should be monitored if the patient is hemodynamically unstable or large fluid shifts are anticipated. Five lead ECG is indicated if the patient has evidence of myocardial ischemia.

POSTOPERATIVE MANAGEMENT

During postoperative period, insulin-glucose infusion should be continued till at least 2 hours after the first meal. Blood sugar should be monitored every 2 hourly and normal insulin regime or oral hypoglycemic agents can be started with the first meal. It is also important to monitor the sodium and potassium levels. Postoperative hypotension is a common electrolyte abnormality and hypokalemia if not answered at the right time may lead to cardiac arrhythmias. Nausea and vomiting should be prevented, and if present, should be treated vigorously. Good analgesia decreases catabolic hormone secretion. Nonsteroidal anti-inflammatory drugs should be used with caution in patients with renal dysfunction. Judicious use of antibiotics and better wound care and postoperative glycemic control can prevent postoperative infection.

Diabetic patients may require surgery as a consequence of their disease process or otherwise. Giving anesthesia to diabetic patients is usually not associated with any additional risk if proper care is taken during pre-anesthetic check-up. Metabolic control at surgery is necessary. Anesthesia should be carried out with careful administration of drugs and fluids to prevent hypoglycemia and hypokalemia. Good glycemic control can prevent postoperative infection.

BIBLIOGRAPHY