Perioperative management of diabetes mellitus and corticosteroid insufficiency

Rina R George

Anil P Hormis

Abstract

The prevalence of diabetes is increasing and is becoming a larger part of the workload for healthcare professionals. Surgery causes a stress response which in turn causes hyperglycaemia. Perioperative hyperglycaemia is associated with a high incidence of surgical complications. There is increasing evidence that tighter glycaemic control is important in reducing complications. Strategies and suggested protocols for the safe and effective management of Type 1 and Type 2 diabetic patients are discussed.

Patients on corticosteroids for co-existing medical conditions and patients undergoing surgery for hypercortisolism may be unable to mount an effective steroid response to surgical stress and need perioperative supplementation. A management strategy for this group is also described as the required extent of steroid replacement is not as high as previously thought.

Keywords Corticosteroids; diabetes mellitus; glycaemic control

This article discusses the perioperative management of patients with diabetes mellitus and patients with corticosteroid insufficiency. Surgery evokes a 'stress reaction' that causes an exaggerated metabolic and hormonal response. This is best managed in the perioperative phase by minimizing the stress response and correcting the hormonal abnormalities. This will ultimately improve surgical outcome.

DIABETES MELLITUS

Prevalence

The prevalence of diabetes mellitus in both adults and children has been steadily rising throughout the world over the last 20–30 years.[1] Data from 2010 reveal that currently 4.2% of the population of the UK have diabetes (2.8 million people). The incidence of Type 2 diabetes is predicted to increase due to the ageing of the population and the rapid rise in the number of overweight and obese people. The risk of Type 2 diabetes rises 10-fold in people with a body mass index (BMI) greater than 30 kg/m^2.[2]

With the increasing numbers of diabetic patients undergoing surgery, and the increased risk of complications associated with diabetes mellitus, appropriate perioperative assessment and management is imperative.

Rina R George *MBBS BMed Sci FRCS Ed is a Specialist Registrar in Surgery at Bradford Teaching Hospitals NHS Foundation Trust, UK. Conflict of interest: none declared..*

Anil P Hormis *MBChB FCARCSI AFICM is a Consultant in Anaesthesia and Critical Care Medicine at the Rotherham NHS Foundation Trust, UK. Conflict of interest: none declared..*

Types

Type 1 diabetes mellitus is characteriszd by autoimmune-mediated destruction of the β cells of the islet of Langerhans. This results in an absolute deficiency of insulin. It usually presents in childhood or adolescence and is treated with insulin supplementation.

Type 2 diabetes mellitus is a metabolic disorder characterized by high blood sugar in the context of insulin resistance and relative insulin deficiency. The insulin resistance occurs in the organs that metabolize glucose such as liver and muscle. There is also inadequate production of insulin from the β cells. This form of diabetes is treated by lifestyle changes, diet modification and oral hypoglycaemic drugs, but some patients may also require insulin. Obesity is considered to be the most important risk factor but there is a strong genetic component.

Pathophysiology

Insulin is a peptide hormone composed of 51 amino acids. It is produced in the β cells of the islets of Langerhans in the pancreas. It has anabolic actions including:

- increased glycogen synthesis (in the liver and in muscle)
- increased fatty acid synthesis (as intracellular triglycerides)
- increased protein synthesis.

If there is a deficiency of insulin then a catabolic state occurs. In Type 1 diabetes, this is characterized by hyperglycaemia, lipolysis, protein breakdown and ketogenesis. These processes are rarer in Type 2 diabetes unless there is an additional stress such as sepsis or dehydration.[3] The state of hyperglycaemia, over time, gives rise to the microvascular (retinopathy and nephropathy), neuropathic (autonomic and peripheral) and macrovascular (heart and cerebro-vascular atherosclerosis) disease processes. The risk of major surgical complications, like impaired healing of wounds and anastomoses, may be worsened by hyperglycaemia.[1]

Diagnosis

Clinical features of diabetes include polyuria, polydipsia, blurred vision, weight loss, history of recurrent infections and peripheral vascular disease. The diagnosis of diabetes is made when a random plasma glucose is greater than 11.1 mmol/litre or when a fasting level is greater than 7.0 mmol/litre on two separate occasions (World Health Organization guidelines).

If any symptoms suggestive of diabetes are present at preoperative assessment, then glucose levels should be taken.

Aims of perioperative management

Although Type 1 and Type 2 diabetes are different diseases, their perioperative management follows similar principles. Surgery, critical illness and trauma cause a stress response mediated by the neuroendocrine system, which causes release of catecholamines, glucagon and cortisol. There is also a relative insulin deficiency, which arises from a combination of reduced insulin secretion and insulin resistance. In non-diabetic patients, postoperative hyperglycaemia occurs via similar mechanisms. The aims of management in diabetic patients should be to:[2]

- avoid hypoglycaemia and hyperglycaemia
- prevent lipolysis and protein breakdown
- avoid loss of electrolytes (potassium, magnesium and phosphate).

Principles of perioperative management of diabetes mellitus

A thorough preoperative assessment is crucial in diabetic patients so that any co-morbidities are recognized and optimized before admission. The aim is to ensure that the glycaemic control is optimized prior to surgery. It is useful to establish an individualized diabetes management plan, agreed with the patient, for the perioperative period.

Referral to a specialist diabetes team should be considered in poorly controlled diabetic patients attending for elective surgery. This should include patients who have lost awareness of hypoglycaemia and may include those with HbA_{1C} greater than 69 mmol/mol (8.5%). There is an increasing trend, especially in newly diagnosed Type 1 diabetics for patients to be treated with insulin via a continuous subcutaneous pump. The regime for this should be discussed with a diabetologist and the patient well in advance of surgery.

Patients with diabetes mellitus should preferably be prioritized first on the operating list in the morning or afternoon lists to avoid prolonged fasting. This will allow patients to restart normal medication and diet as soon as possible after surgery. It is useful to consider diabetic patients for enhanced recovery programmes if pathways exist.

Diet-controlled diabetes

These patients are not at risk of hypoglycaemia. They can be fasted as per normal anaesthetic guidelines. Their blood sugar should be checked before meals. The diabetes team should be consulted if their glucose levels rise above 10 mmol/litre.

Patients taking oral hypoglycaemic drugs

If the patient is expected to eat or drink within 4 hours then the surgery is classified as minor. This short starvation period means that the patient should not miss more than ONE meal. All other surgery is classed as major.

For minor surgery, patients taking oral hypoglycaemic medications, the tablets should be omitted on the morning of surgery. The blood glucose should be measured 1 hour preoperatively. After surgery, the blood glucose should be measured 2-hourly until eating and the oral hypoglycaemic tablets started with first meal. If the preoperative blood glucose is greater than 17 mmol/litre then an insulin infusion should be considered or the patient may need further specialist input for preoperative optimization.

For major surgery the management is more intense. Patients on the morning list should fast from midnight, omit their oral hypoglycaemic medication in the morning and should be started on a variable rate intravenous insulin infusion (VRIII) at 6am (see below). Patients on the afternoon list should have a light early breakfast and fast from 7am and start a VRIII at 11am.

The blood glucose should be measured every 2 hours after the start of the infusion. Post operatively, it should be measured 1-hourly for 4 hours and then 2-hourly afterwards.

Patients on insulin therapy

There are a number of regimes for insulin therapy. Some patients may need up to five insulin injections a day. The regimes include a long-acting insulin with fast-acting insulin supplementation around meal times. Some preparations are mixtures of long- and short-acting insulin. As mentioned above, patients may also be treated with continuous subcutaneous pumps of insulin. Patients on insulin therapy should be placed first on the list whenever possible.

For minor surgery, patients should omit their normal dose of insulin if their morning glucose is less than 7 mmol/litre. If their glucose is greater than 7 mmol/litre they should administer half the normal dose. Blood glucose should be checked 1 hour before surgery and 2-hourly postoperatively until eating is resumed. The normal insulin dose can be started with the first meal.

For major surgery, the patients will be fasting from midnight. They should be placed on a VRIII at 6am. The insulin infusion can be stopped and the normal dose of insulin can be restarted with the resumption of oral intake.

There is a comprehensive review of the various types of insulin and their perioperative management in the NHS Diabetes document *Management of adults with diabetes undergoing surgery and elective procedures: improving standards*.[4]

Intravenous glucose-insulin infusions

The most widely used regimen used in the perioperative phase is the 'sliding scale'. However current guidance from NHS Diabetes[4] suggest the use of a VRIII.

Intravenous insulin 'sliding scale'

Most hospitals use an infusion that consists of 50 units of soluble insulin mixed with 49.5 ml 0.9% saline. This gives a concentration of 1 unit of insulin per ml. The blood glucose is measured hourly and the rate is altered accordingly (Table 1). An infusion of 10% dextrose is infused at a rate of 100 ml/hour. A dose of 10 mmol potassium should be added to every 500 ml of 10% dextrose. Potassium levels should be monitored closely as well. Please check your own hospital's protocol.

Variable rate intravenous insulin infusion (VRIII)

This new regime is being recommended as a replacement for the traditional 'sliding scale'. The main restriction to its widespread implementation is that the crystalloid fluid suggested below is not readily available.

The aim of the VRIII is to achieve and maintain normoglycaemia, ideally blood glucose between 6 and 10 mmol/litre. Please check your hospital's own protocol.

The VRIII is set up as described below.

- A 50-ml syringe with 50 units of insulin Actrapid in 49.5 ml of 0.9% sodium chloride solution (1 unit per ml).
- The initial substrate to be co-administered with the VRIII is 0.45% sodium chloride, 5% dextrose and 0.15% potassium chloride solution. This should be given using an infusion pump.
- Delivery of the insulin and the substrate solution must be via a single cannula using a giving set incorporated with one-way and anti-siphon valves.
- Set the rate of fluid maintenance according to the patient's requirement, usually 85–125 ml/hour.