CHAPTER **39**

PERIOPERATIVE MANAGEMENT OF THE DIABETIC PATIENT: An Update

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INTRODUCTION

One of the most commonly encountered diseases from the perspective of a podiatric physician is diabetes mellitus. According to data compiled from the American Diabetes Association in 2011, there are currently approximately 26 million people in the US with diabetes, and 79 million who are prediabetic (1). With the increased incidence of diabetes among US citizens, a thorough understanding of this disease is essential. The aim of this article will be to briefly discuss background information on general physiologic responses of the body to surgery, with a primary focus on the perioperative management protocols of the diabetic patient.

BACKGROUND

To review the basics of diabetes, the two most commonly occurring types are Type I and Type II diabetes. Type I diabetes is caused by a destruction of the insulin producing B-cells of the pancreas, and is usually a result of T-cell autoimmunity against these particular cells, which can cause a marked loss in insulin. Type II diabetes, on the other hand, is proposed to be secondary to a reduced sensitivity to insulin and usually has only a small variation in insulin levels. Typically, type I diabetes has an early-onset and is found in patients of normal body habitus, whereas type II diabetes is characterized by a late-onset, usually encountered in obese individuals. Mainstays of treatment for type I diabetes is insulin replacement, while type II diabetics usually involves lifestyle and diet modifications. If unsuccessful, the patient will be placed on a regimen of oral hypoglycemic agents (OHA), which involve any number of different mechanisms to reduce the body's glucose levels. These are usually sufficient for maintaining sugar levels, although insulin may be used periodically as a supplement.

PHYSIOLOGIC RESPONSE TO SURGERY

It is important to understand the body's physiologic response to the stress and stimuli involving surgery and how those effects relate to a metabolic disease state. A number of factors must be taken into consideration, specifically patient anxiety, fasting state, the effect of anesthetics, surgery-induced stress on the body, all of which come into play in the metabolic processes surrounding the perioperative period (2). To discuss the breadth of hormonal effects of these different factors in detail would be quite extensive, so to simplify, surgery as a whole should be understood as a stress-inducing event. Any stress-inducing event is generally a catabolic process, leading to the stimulation of classically catabolic hormones such as catecholamines, glucagon, cortisol and growth hormone, which all directly or indirectly increase blood glucose. Secondarily, cortisol and catecholamines are known to reduce insulin sensitivity. Further, insulin secretion and insulin action are inhibited in stress-induced states (2).

Given those general concepts, one can understand how a surgical event can induce hyperglycemia. Normally, the hormonal imbalance and resultant hyperglycemia usually encountered during surgery in a nondiabetic patient may be counteracted by an increase in insulin secretion. However, in the diabetic patient, the lack of and/or the insensitivity to insulin would be ineffective in counteracting any concurrent hyperglycemia. Subsequently, this predisposes the type I patient to ketoacidosis, while in the type II patient may lead to a hyperglycemic episode and hyperosmolar state (2).

These complications can be further exacerbated when combined with the common issues involved with fluid loss, dehydration, and fluid under-replacement that one may come across during the perioperative period. Generally speaking, regional anesthesia techniques including spinal and epidural nerve blocks circumvent the majority of these potential complications, although they carry their own associated co-morbidities (i.e., epidural abscess, local infection, etc.) (2). However, the patient's blood glucose should ideally be well-controlled perioperatively and the anesthesic used should be selected based on the surgical procedure performed rather than out of concern for a perioperative event.

HYPERGLYCEMIA AND ITS EFFECTS ON POSTOPERATIVE OUTCOMES

Why is it so important to diligently monitor the patient's blood sugar levels perioperatively?

It is well-documented within the literature that diabetic postoperative infection rates are higher than those found in a nondiabetic patient. Several studies focused on foot and ankle surgery have outlined the differences in infection rates in diabetic versus nondiabetic patients. Wukich et al published a recent study comparing general postoperative infection rates in diabetic versus nondiabetic patients, where 2.8% of the nondiabetic population demonstrated infections while 13.2% of the diabetic population demonstrated infections (3). Flynn et al compared infection rates in diabetic versus nondiabetic patients treated for closed ankle fractures, finding that 8 (32%) of 25 diabetic patients developed an infection, while only 6 (8.8%) of 68 of nondiabetics experienced the same complications (4). This significant difference encountered in infection rates may be attributed to a number of factors.

Numerous studies have outlined the deleterious effects of hyperglycemia on PMN leukocyte function and immune response (5-7). There are a variety of effects on PMN leukocyte function: decreased phagocytosis, impaired bacterial killing, and chemotaxis, and increased adhesiveness (5). Many studies were done in vitro and noted that the threshold for these effects was 200 mg/dL. It has been shown in patients with type I/II diabetes that granulocyte chemotaxis and phagocytic function are adversely affected by hyperglycemia, particularly when blood glucose levels are greater than 250 mg/dL (8, 9). Fibroblast function may be impaired, and collagen synthesis is suppressed by hyperglycemic states when glucose levels are higher than 200 mg/dL (10). Impaired wound healing is what follows from the aforementioned studies, as the wound healing process depends on proper leukocyte function and collagen synthesis. With lower rates of wound healing, one may encounter higher rates of infection, indicating the importance of appropriate glycemic control peri-operatively within the patient. Younger et al performed transmetatarsal amputations (TMAs) in 21 patients and compared their result to 21 patients with failed TMAs who went on to further transtibial amputations (TTAs). The TTA group was noted to have a significantly higher HbA1c levels than those patients with successful TMAs (7). Furthermore, the presence of micro and macroangiopathy, (which is commonly encountered in diabetics) may lead to further delays in wound healing that may also increase the risk of infections. Unfortunately, glucose's direct effect on osseous healing is not well-investigated.

PREOPERATIVE WORK UP

The appropriate preoperative workup of the diabetic patient requires a close collaboration with the podiatric physician, the patient's primary care physician, and/or endocrinologist. Numerous aspects of the patient's history must be taken into account, including the type and duration of the diabetes, potential complications, the type of surgical procedure, and the type of anesthesia that will be necessary. Other particulars about the patient history from the podiatric standpoint, including ischemia or sensory/autonomic neuropathy, are important to note because these can increase the risk of cardiovascular events including arrhythmia and hypotensive/hypertensive episodes (5).

Along with the basic preoperative laboratory work-up (CBC, BMP, EKG, etc.), it is important to also consider the patient's hemoglobin A1c, which has generally been considered the standard laboratory marker for long-term assessment of a patient's glycemic control. Ideally, the normal range should be anywhere less than 4-6% and no greater than 8.5% (11). This, according to the literature, is more difficult to achieve than one would think. A study published in 2002 revealed that less than 50% of diabetic patients undergoing surgery had an HbA1c at the recommended level of <7%, while 18% of subjects within the study had a level >8.5% (12).

Upon arrival to the preoperative area, the patient should have a blood glucose level drawn. It is traditionally believed that attaining appropriate blood glucose control preoperatively can lead to better postoperative outcomes. For simplicity's sake, and according to the majority of the literature, it is easiest to discuss the immediate preoperative, intra-operative, and postoperative management in terms of whether the patient undergoes minor surgery or major surgery. From one study's perspective, minor surgery can be defined as any surgery in which the patient can resume oral food intake within 6 hours after the operation (2). Major surgery can be defined as any type of surgery where the patient may not resume oral food intake within the first 6 hours after the operation, or when general anesthesia may be required for longer than 1 hour (2).

MINOR SURGERY

Type 2 diabetics who are treated solely with diet modification and/or OHA undergoing minor surgery are relatively simple to monitor. Table 1 reflects the OHAs and their perioperative monitoring protocols, with the literature remaining consistent that with the exception of metformin, OHAs should be discontinued on the morning of surgery (5). Ghirlanda and Schiff both note that metformin should be discontinued 48 hours prior to the date of surgery, while Mokshagundam claims that it should be discontinued on the day of surgery (2,5,9). Blood glucose levels should be checked prior to surgery, and then every 1-2 hours until the patient resumes oral food intake and their usual drug regimen. Any unexpected hyperglycemia may be treated with single doses of short-acting or regular insulin (Table 1).

Type 2 diabetics requiring insulin (usually 2 or more doses daily) and type I diabetics are approached in relatively the same manner. Long-acting insulin (i.e., Lantus) can be given the night before surgery, while on the evening prior to or morning of surgery the patient should receive a modified dose (usually half) of their intermediate-acting insulin. The blood sugar should then be checked prior to the procedure and then every hour during the procedure. The patient may then continue their usual regimen once oral food intake is resumed. Type I patients are unique in that their proclivity for ketoacidosis necessitates much closer observations of postoperative blood glucose levels. Significant glycemic fluctuations should be avoided, and if they occur, should be counteracted with single doses of short-acting or regular insulin subcutaneously or a short-acting intravenous insulin infusion.

MAJOR SURGERY

A noninsulin-dependent patient with adequate glycemic control (presenting with blood glucose levels <150 mg/dL) can be treated much the same way as a patient undergoing minor surgery (13). Otherwise, any patient undergoing major surgery should always be considered for an insulin infusion, as this is the modality of insulin administration that allows for the tightest control and monitoring (14). Careful consideration must be given to numerous circumstances, such as prolonged cases, patients that may need to be transferred to the intensive care unit postoperatively, patients with septicemia and elevated glucose levels, and unstable type I patients, etc. (14). Typically, the insulin infusion is begun in patients who may face any of the aforementioned circumstances, or in patients who present preoperatively with significant elevations in blood sugar (>200 mg/dL) (14). The patient is usually started on a D5W intravenous infusion at anywhere from 60-100 cc/hour in order to avoid a concurrent rapid hypoglycemic episode (14). Adjustments of the insulin drip are made accordingly intra-operatively, as it should be monitored at least once hourly with a goal being to maintain levels between 100 and 150 mg/dL (14). If the glucose level is <80 mg/dL, then one ampule of D10W is given intravenously and the glucose is rechecked in 30 minutes (14). It is not within the scope of this discussion to review appropriate insulin dosing modifications. This information is well outlined in an article by Mokshagundam published in 2004 (14).

EMERGENCY PATIENT

The emergent surgical patient is usually in a state of metabolic flux, with wide variations in laboratory values.

Table 1

LIST OF ORAL HYPOGLYCEMIC AGENTS AND APPROPRIATE DISCONTINUATION/RESTART TIMES

Medication	Discontinue	When to restart/special instructions
Metformin (Glucophage)	48 hrs prior - Day of surgery	Post-op; restart pending renal fxn stability
Thiazolidinediones (i.e. Pioglitazone, Rosiglitazone)	Day of surgery	Post-op; monitor LFT's and watch for fluid overload
Sulfonylureas (i.e. Glimepiride, Glypizide, and Glyburide)	Day of surgery	Post-op; restart when able to eat consistently
Meglitinides (i.e. Repaglinide, Nateglinide)	Day of surgery	Post-op; restart when able to eat consistently
α-glucosidase inhibitors (i.e. Acarbose, Miglitol)	Day of surgery	Post-op; restart when able to eat consistently

Taking a surgical standpoint, it is necessary to weigh the benefits and risks of performing the operation, and whether those benefits outweigh the risks associated with delaying a normalization of the patient's metabolic status prior to surgery. When surgery is necessary, it should not be postponed and when it is not necessary, it should be postponed in favor of metabolic stabilization. If the surgery is absolutely necessary, rapid corrections of hydration levels and electrolyte imbalances may be achieved with a central line and an intravenous insulin infusion (2). In order to appropriately evaluate the current metabolic state, a STAT CBC and BMP should be ordered, with careful attention to the glucose and potassium levels perioperatively. A continuous insulin infusion may then be maintained while monitoring glucose every hour and potassium levels every 2-4 hours including postoperatively (2).

POSTOPERATIVE MANAGEMENT

In the foot and ankle surgical setting, patients typically resume their preoperative diets after surgery, especially after minor procedures. The postoperative glucose and potassium levels should be determined in the postanesthesia care unit and normalized before sending outpatients home.

For outpatients placed on intravenous infusion intra-operatively, the patient should be stabilized and oral intake should be tolerated prior to discontinuing the drip (13). After discontinuing the drip, blood sugar should be normalized and the patient's regular insulin or OHA regimen may be resumed with the next meal (13). For inpatients, the drip may be continued until the patient tolerates their first postoperative meal, after which it may be discontinued prior to the next meal. At this point, the patient may resume their regular regimen, whether it consists simply of diet control, OHA, a combination of OHA/insulin, or insulin sliding scale.

The sliding scale has been the mainstay and most commonly used method of dosing insulin, although it has inherent flaws. The insulin sliding scale follows a rigid dosing regimen based on the level of blood glucose, with incremental increases in insulin dosing based on increased glucose readings. By dosing insulin based on a prior glucose reading, which may or may not have fluctuated since the reading, the sliding scale is criticized as a counteractive method rather than a proactive method of glucose control (5). Also, it does not take the patient's insulin sensitivity, which may lead to over- or under-correction of the glucose level (5). Newer modalities of insulin administration and monitoring have recently become available, of which there are numerous systems capable of monitoring glucose in real time. This allows the delivery of a much more physiologically accurate insulin infusion based on postprandial glucose levels.

SUMMARY

As the podiatric community continues to grow, especially as a surgical specialty, it is important to understand the diabetic surgical patient in the perioperative setting. Not only is the diabetic population growing steadily, but they are well-known as having a particular stake in the field of podiatric medicine. Maintaining proper glycemic control throughout the preoperative, intra-operative, and post-operative period may help eliminate easily controllable factors in preventing a proper surgical outcome, and should be one of the main goals in the patient's management. In conclusion, a full and thorough understanding of the appropriate preoperative work-up is essential. This can be achieved by taking part in a concerted and collaborative effort with the patient's other treating physicians, while also thoroughly educating the patient. Concurrently, careful intra-operative and postoperative monitoring is also necessary and helpful in achieving optimal results.

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