Perioperative control of diabetes mellitus - revisited

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Failure of established preoperative diabetic protocols is a common problem facing the anesthetist, one which compounds the difficulty of managing the diabetic patient intraoperatively. Utilizing case presentations, the authors suggest a need to reexamine the traditional approach to this problem and advocate an alternative approach that focuses on the intraoperative control of glucose.

To achieve optimal care for diabetic patients, the significance of abnormal glucose levels must be viewed by the surgical staff with the same degree of importance as that of the surgery. Although numerous strategies have been recommended for the diabetic surgical/anesthesia candidate, application of such strategies is usually based on local convention or personal preference, and seldom represents a cooperative effort between internist, surgeon, and anesthetist.

Failure of established diabetic protocols is common, and patients often arrive in the operating room in a less than optimal metabolic state. As no superior method exists for prescribing insulin to patients who are to be anesthetized, and protocols do not produce their desired results, there is a need to develop a reliable methodology for the diabetic patient population. The following case descriptions support this conclusion.

Case reports

Case 1: A 36-year-old 41 kg female with juvenile onset diabetes of 31 years' duration was admitted for closed vitrectomy under general anesthesia for severe retinopathy. Her normal regimen consisted of 22 units of lente insulin each morning and an American Dietetic Association (ADA) recommended diet. The patient was admitted one day prior to the proposed surgery and received her customary insulin schedule. A random glucose level was 272 mg/dl, and medical clearance for surgery was granted.

On the morning of surgery, the patient received 5 units of regular insulin subcutaneously, and an intravenous solution of 5% dextrose in physiologic saline was started. Thirty minutes prior to surgery, she received 5 units of regular insulin subcutaneously and was transported to the operating room. She arrived confused, distressed, complaining of headache. Blood glucose was 66 mg/dl. The intraoperative and postoperative periods were characterized by wide swings in blood glucose levels (range 40 mg/dl to 396 mg/dl). Glucose determinations in the operating room were made with the Ames Glucometer.*

Case 2: An 85-year-old 79 kg male with a histo-
tory of diabetes for more than 75 years was admitted for excision of an acoustic neuroma. Multiple systems disease (which included recurrent congestive heart failure, hypertension, 45-pack per year cigarette smoking history, recent viral hepatitis, and occasional transient ischemic attacks) complicated the clinical management of this patient. His current insulin regimen at home was 15 units of lente insulin every morning with a second dose at dinner time (early evening). Frequently, he supplemented his second dose with a small amount of crystalline insulin.

On the morning of surgery, 10 units of lente insulin were given subcutaneously, and a physiological saline solution without dextrose was started. Blood glucose was 58 mg/dl. Appropriate intervention raised the blood glucose to 211 mg/dl and surgery was performed. The patient experienced wide ranges in blood glucose for the following eight days.

Case 3: A 39-year-old 63 kg male with juvenile onset diabetes of 19 years' duration was admitted for arthroscopy and possible meniscectomy as a result of a work-related incident. Rigid diet and 15-25 units of lente insulin every morning appeared to provide satisfactory control of blood glucose. On the morning of surgery, 10 units of lente insulin were given subcutaneously, and an intravenous solution of dextrose 5% in lactated Ringer's solution was started at 115 cc per hour.

When the patient arrived in the operating room four and one-half hours later, his blood glucose was 420 mg/dl. The operative course proceeded smoothly. Intravenous insulin was utilized by the anesthetist intraoperatively.

In all three of these cases, the patients were discharged in satisfactory condition, but the wide swings in glucose level related to their respective cases could have been avoided.

Discussion

The metabolic relationships operational in diabetes mellitus, though complex, are not a part of the discussion of this paper, and the reader is referred elsewhere for details. It is appreciated that the diabetic patient presenting for anesthesia is at higher risk than the non-diabetic patient due to numerous concomitant problems associated with the disease. Among these conditions are microvascular and atherosclerotic processes, renal disorders, glucose abnormalities, obesity, gastrointestinal dysfunction, and polyneuropathy. Juvenile onset diabetics vary from hypoglycemia to hyperglycemia and develop ketoacidosis more easily than the maturity onset diabetic.

The metabolic derangements of the patients described in cases 1, 2, and 3, were relegated to a level of secondary importance by the surgical staff who frequently seemed bewildered by the significance of abnormal glucose levels. We believe that abnormal metabolic parameters add to the anesthetic risk; patients should be in the best possible condition for the anesthetic experience. The insulin protocols selected for these patients were inadequate, resulting in less than optimal conditions for anesthetic administration.

Until pancreatic transplantation, with its attendant automatic regulation of insulin dosage, becomes readily available to the diabetic patient, it is likely that experimental work will continue to be focused on appropriate pharmacological intervention to maintain adequate insulin levels. Precise mechanisms of insulin's anabolic and anticyclotonic activity are still not fully appreciated, although the agent has been employed in the treatment of diabetes mellitus for more than half a century. Considerable information has accumulated over the last decade concerning bioavailability and the pharmacokinetics of insulin. Extensive debate has resulted over the indications for the efficacy of the newer and purer insulin preparations. Proper employment of insulin in the medical management of the patient requires careful attention to its pharmacological consequences.

The onset of lente insulin is 1-4 hours, with peak activity in 8-12 hours. Duration of action is 18-24 hours. Regular insulin is an acidic protein, and at physiologic body pH, it is soluble in body fluids and rapidly absorbed from subcutaneous sites. Its onset is one-half to one hour, peaking in 2-3 hours. The duration of action is 5-7 hours following subcutaneous injection. Intravenously administered crystalline insulin is rapidly cleared from the circulation by the kidney. Its serum half-life is 5-10 minutes. Because insulin maintains its action at tissue receptor sites for some time after plasma clearance, the effect of an intravenous bolus may be noted for 30-60 minutes. Many authorities view glucagon as a physiologic antagonist to insulin.

Strict intraoperative control of blood glucose is advantageous since hyperglycemia produces impaired neutrophilic phagocytosis and wound healing, leads to negative nitrogen balance, and can produce diuresis (with attendant dehydration), electrolyte abnormalities, and hyperosmolar coma. Hypoglycemia produces lipolysis which may lead to increased myocardial oxygen demands. If profound hypoglycemia ensues, severe irreversible brain damage may result. We believe that strict
control of intraoperative glucose levels, and maintenance of stringent control postoperatively can do much to avoid major physiological problems.

Data abounds to suggest that some cellular hyporesponsiveness to exogenous insulin exists in diabetics. Insulin resistance frequently manifests intraoperatively, and this further exaggerates an already complicated situation. Palumbo advocates that plasma glucose be rigidly controlled between levels of 80-120 mg/dl perioperatively; such control is easily achieved in contemporary anesthetic practice.

Taitelman demonstrated wide fluctuations in blood glucose in a group of patients coming to surgery despite careful intraoperative interventions. However, all these patients received a standard insulin protocol. Fletcher and associates showed that neither the preanesthetic insulin dosage nor the time of operation influences the intraoperative change in glucose concentration. Walts and associates determined that morning insulin protocols do not afford protection from intraoperative hyperglycemia and may lead to hypoglycemia.

Protocols directed toward managing “average” diabetic patients have been associated with a staggering degree of failure. It has been proposed that perhaps protocols serve as a matter of practitioner expediency. Walts strongly called for the abandonment of all protocols. We support this philosophy.

No protocol has been associated with 100% success in the management of the diabetic patient in the preoperative or intraoperative period. We propose the following recommendations for the management of the diabetic patient undergoing anesthesia:

1. Abandon traditional diabetes mellitus protocols.
2. Obtain a fasting serum glucose level on the morning of surgery. If more than two hours elapse between sampling and surgery, a repeat determination should be performed.
3. An intravenous line should be established in the morning to provide 5-10 gm of dextrose/hour, and to serve as an access to the circulation. A second substrate intravenous should be established to provide for metabolic “fine tuning” (that is, for exogenous insulin and dextrose supplementation).
4. Intraoperative blood glucose determinations should be made at least every 30-45 minutes when insulin therapy is not employed. More frequent determinations (at least every 15-20 minutes) should be done when insulin is being used. Intraoperative insulin requirements may vary considerably, and hour-to-hour changes can occur as the surgical stress varies.

5. Titrate the insulin (incremental bolus or infusion pump) to maintain blood glucose level within a range of 100-200 mg/dl. Titration helps counterbalance the variable percentage of insulin absorbed to the delivery container wall.

6. Avoid subcutaneous insulin therapy until the patient is fully recovered and hemodynamically stable. Uptake of insulin from subcutaneous deposits can be significantly influenced by temperate variations, blood volume deficit, and the effects of various anesthetic agents.

7. Continue judicious monitoring of the blood glucose level in the recovery room and notify the medical consultant at the completion of surgery in order to provide continuation of adequate diabetic medical care.

Although some would argue that tight perioperative control of diabetes may not be warranted, we feel that it is incumbent upon the anesthetist to continue to look for methodologies that will have a salutary impact upon the diabetic surgical patient. Such control is currently available, is likely to become the state of the art, and does not significantly impinge on the attention which the anesthetist is required to devote to the anesthetized patient.

REFERENCES
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AUTHORS

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