Surgical Management of the Diabetic Patient

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Preface

Diabetes is indeed a unique disease, given its multifarious presentations and propensity for insidiously involving multitudinous organ systems simultaneously. Individuals with diabetes characteristically have significant underlying abnormalities in the absence of overt symptoms. It thus becomes the responsibility of the physician to assiduously investigate the presence of complications. This is particularly critical when diabetic patients undergo surgical procedures. It is not uncommon for certain manifestations (e.g., coronary artery disease, peripheral vascular disease, neuropathy, nephropathy) to become apparent for the first time during the preoperative evaluation. Failure to identify these complications can expose the individuals to greater risk than is already likely, given their diabetic status.

Diabetes care involves participation of a multidisciplinary team to assure a beneficial outcome. Optimally, planning for surgery should start quite early so that last minute decision-making can be averted. As detailed in this book, evaluation of cardiac, renal, ophthalmologic, neurologic, and vascular status needs thorough exploration, preferably performed as an outpatient. Attention and remediation of significant deviation in blood glucose control and correction of other biochemistries, as well as investigation for occult infections (e.g., cystitis) should be entertained preoperatively. The diffuse nature of vasculopathy in diabetic patients continuously tests the skills of the internist and surgeon as they attempt to preserve extremities and, most importantly, provide the patient with a reasonable lifestyle and longevity. Meticulous attention to hemodynamic monitoring, nutrition, wound healing, and metabolic control is continuous throughout the perioperative period. The anesthesiologist and surgeon need to be informed even if subtle clinical findings, such as neuropathy, are present so that positioning, for example, during a lengthy procedure takes this complication into consideration. Similarly, the presence of retinopathy may also require exquisite attention to head positioning.

Pre-discharge planning should be instituted early during hospitalization and, as described in greater detail, requires comprehensive assessment of both the patients' and their families' knowledge and skills related to diabetes management. Counseling and reassurance should be provided to allay anxiety, particularly in a newly diagnosed patient. This may, at times, require referral for individual therapy; participation in a group situation is often invaluable.

This book affords practical information for the detailed assessment of the diabetic patient from the early stages when surgery is considered through the surgical and postsurgical periods as well. Consideration is given to those issues vital to patient well-being at each phase. Specialized surgical interventions are also provided in detail. Scientific information is offered to enhance the understanding of the relationship between the biochemical perturbations of diabetes and its clinical manifestations.

Michael Bergman
Gregorio A. Sicard

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The editors express their sincere appreciation to all the authors who have shared their expertise to formulate a broadly based resource for practitioners encompassing a variety of specialties. It is the expressed hope and avowed purpose of this book to assist in providing enhanced quality of care to the millions of patients afflicted with diabetes and, in so doing, to improve their lives.

We also express our gratitude to Raven Press for accepting so graciously the ideals and goals that this book embraces. In particular, Lisa Berger and Susan Berkowitz have worked very diligently in the preparation of this manuscript.

The warm support, encouragement and wisdom of Dr. Philip Felig is genuinely appreciated. We especially thank him for his ongoing counsel as this book was compiled. Finally, sincere gratitude is expressed to H.Y. Pan, M.D., Ph.D. for providing the latitude, guidance, and inspiration for completing this work.

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1
Introduction

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The past 15 years have witnessed a burgeoning of knowledge regarding diabetes mellitus. While finding a cure for diabetes remains an elusive goal, a far better understanding of the etiology and pathogenesis of diabetes has emerged that is grounded in new insights gained from molecular biology and immunology in addition to physiology and biochemistry. Coupled with these new insights in basic science has been progress in the management of diabetes. The day-to-day care of the motivated and compliant diabetic patient generally involves surveillance of blood glucose levels, assessments of control by glycohemoglobin determinations, and tailoring of insulin doses, oral agents and/or diet to optimize blood glucose level control. What would have been considered unusually meticulous efforts at control of diabetes 15 years ago constitutes a fairly commonplace approach today.

The improvement in the lifespan of the diabetic patient has increased the likelihood that they will encounter conditions requiring surgical intervention. Furthermore, there have been major advances in the surgical management of coronary artery disease and peripheral vascular disease, conditions for which diabetic patients are at increased risk. Renal transplants are now done fairly frequently in diabetic patients and pancreatic transplants are no longer rarities. As a consequence, the management of the diabetic patient in the perioperative period is a circumstance with which the surgeon and internist must deal with increasing frequency.

Surgical intervention is also likely to result in challenging issues of nutritional management in the diabetic patient. When periods of parenteral nutrition or enteral alimentation are required, the decisions regarding choices of fluid regimens, sources of calories, and doses and routes of insulin administration are quite different from the diet and/or insulin regimens employed in the ambulatory, conventionally fed person with diabetes.

It is the premise of this book that the commitment to optimize the metabolic milieu that characterizes current management of diabetes extends to the surgical as well as the medical service of the modern hospital. Implicit in this approach is the concept that successful medical management of the diabetic patient with a surgical condition is a key element in determining the ultimate success of the surgical procedure.

Attention to the details of management of diabetes in the surgical patient is not solely directed at minimizing hyperglycemia, but is also concerned with avoiding hypoglycemia. This is particularly true when the normal waking signals of hypogly-

cemia become inoperative because of general anesthesia or when normal feeding mechanisms are precluded.

The medical management of the diabetic patient who requires surgery depends, of course, on the nature of the surgical procedure and the comorbid status of the patient as well as the prior status of the diabetic control. The various chapters constituting this book provide the principles and practical details for managing the diabetic patient in a variety of surgical conditions. Guidelines are offered so that management can be individualized, given the inherent variability of diabetes in type I (insulin dependent) as well as type II (noninsulin dependent) patients.

Clearly the diabetic patient requiring surgery is often a challenge to the surgeon as well as the internist. Achieving a successful outcome by applying sound metabolic management is consequently all the more gratifying to the patient as well as the physician.

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2
Carbohydrate Metabolism and Surgery

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In their classic study of the relationship between diabetes and surgery, Galloway and Shuman noted that many diabetic patients undergoing surgery were hyperglycemic, and that the major complication of surgery in this group of patients was an increased incidence of postoperative infection (1). Although there is still debate about the mechanism of this increased susceptibility to infection, hyperglycemia alone can result in a reduction in the phagocytic activity of leukocytes (2). Hyperglycemic diabetic patients may also have impaired healing of their surgical wound, for diabetic animals who are hyperglycemic at the time of surgery have poorer wound healing than diabetic animals whose hyperglycemia is corrected with insulin prior to surgery (3).

General anaesthesia and surgical procedures result in a series of hormonal and metabolic changes that can result in a catabolic state with major tissue protein breakdown and nitrogen loss. Administration of 100 g of glucose to a nondiabetic patient undergoing surgery results in a 30–60% reduction in nitrogen loss during the postoperative period (4). Infusions of amino acid solutions result in a further reduction in the postoperative nitrogen loss (5). When patients with type I diabetes and impaired insulin secretion undergo surgery, there is an increase in the secretion of insulin-antagonistic hormones (such as growth hormone, glucagon, cortisol, norepinephrine, and epinephrine) which in turn increases the problem these patients already have in utilizing glucose and amino acids. Thus, their catabolic state can be even greater than that of nondiabetic patients undergoing surgery.

This chapter describes the pattern of baseline intermediary metabolism and hormonal regulation in nondiabetic and diabetic patients and some of the major changes in intermediary metabolism and hormone secretion that can occur following surgery in these two groups. Further details on intermediary metabolism and hormonal control of homeostasis and their alterations in diabetic subjects can be reviewed for further details (6, 7).

INTERMEDIARY METABOLISM

In any discussion of carbohydrate metabolism, it is prudent to begin with a general discussion of the chemical processes it encompasses. These reactions make it possible to use the energy in carbohydrates as fuel to carry out the physiologic work of

cells. Energy is supplied to cells in the form of high-energy intermediary compounds, such as adenosine triphosphate (ATP). These compounds are capable of storing and releasing energy when coupled with the proper enzymes or energy transfer systems. One of the major purposes of biochemical processes of intermediary metabolism is to increase the production of these high-energy phosphate compounds.

Carbohydrate digestion occurs in the gastrointestinal tract prior to absorption. The principal forms of carbohydrate in the human diet are starch, sucrose, and lactose. As outlined in Fig. 1, these disaccharides are broken down into the monosaccharides glucose, galactose, and fructose. Glucose is the major dietary monosaccharide and constitutes approximately 80% of the total monosaccharides that are ingested.

Glucose, galactose, and fructose are rapidly absorbed from the gastrointestinal tract and transported to the liver via the portal system to be further metabolized. Galactose metabolism is outlined in Fig. 2 and fructose metabolism is outlined in Fig. 3.

Fructose does not require insulin for its initial metabolism, and it has therefore been used as a glucose substitute in parenteral alimentation and in dietary supplementation. Fructokinase is very active in the liver; this can result in rapid and substantial depletion of ATP and inorganic phosphate. An increase in purine degradation leads to an increase in liver adenosine monophosphate (AMP), which results in phosphorylase activation and a subsequent increase in glycogenolysis. In addition, fructose metabolism allows metabolites to enter the glycolytic pathway after the metabolic step catalyzed by phosphofructokinase, which allows an important control point to be bypassed.

Because glucose can be used by all cells as a source of energy, the next part of this discussion focuses on the metabolism of glucose. The primary metabolic pathways by which glucose is metabolized, as well as the interrelationships between the

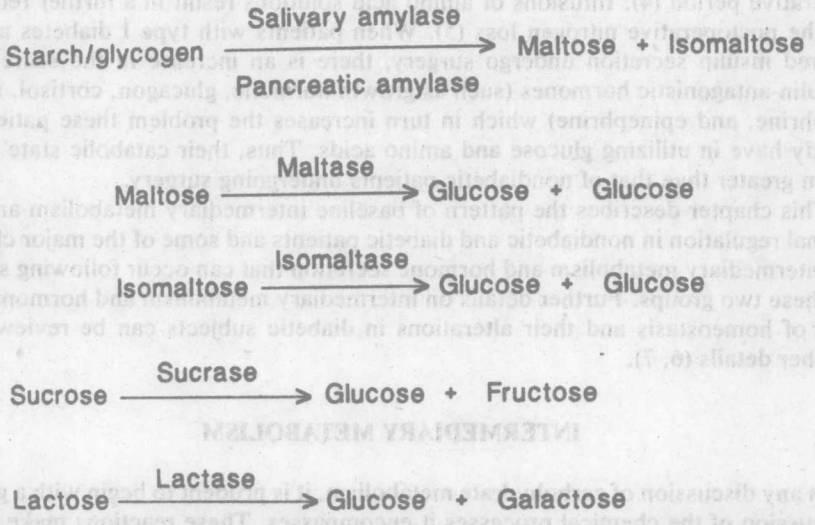

FIG. 1. Digestion of starch, glycogen, and disaccharides to their monosaccharide components in the digestive tract.