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The Stress Response to Surgery and Oral Carbohydrate Loading of Patients with Diabetes Mellitus: A Case-Based Review

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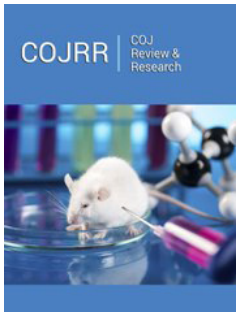

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Abstract

Preoperative oral carbohydrate loading improves outcomes of major elective surgery. However, the preoperative administration of oral carbohydrate loads to patients with diabetes mellitus remains controversial. An illustrative case highlights several issues. Consider, a 63-years-old man with type 2 diabetes and ischaemic heart disease having laparoscopic right hemicolectomy for colon cancer. Oral carbohydrate loading is not administered preoperatively. The postoperative blood glucose control is poor. Preoperative oral carbohydrate reduces insulin resistance. In this context, it is important to determine whether preoperative oral carbohydrate loading may improve postoperative glucose control in patients with insulin resistance. High quality randomized controlled trials are, therefore, urgently required.

Keywords: Preoperative assessment; Diabetes; Oral carbohydrate loading; Stress response; Insulin resistance

Introduction

Patients undergoing major elective surgery can benefit significantly from preoperative oral carbohydrate loading [1]. Reducing the incidence of thirst, hunger, fatigue, malaise, anxiety, dryness of the mouth, and postoperative nausea and vomiting are particularly advantageous [2]. Furthermore, preoperative oral carbohydrate loading reduces the stress response considerably [3]. Indeed, insulin resistance is lowered by up to 50% after major surgery [3]. However, the use of oral carbohydrate loading in the perioperative management of patients with diabetes mellitus remains controversial.

Clinical Scenario

A 63-years-old man presented to the pre-anaesthesia clinic before laparoscopic right hemicolectomy for colon cancer. He had ischaemic heart disease (coronary artery stents were inserted 2 years prior to this presentation) and type 2 diabetes mellitus. Although he was compliant with oral hypoglycaemic agents (metformin and sitagliptin), the overall blood glucose control was unsatisfactory (HbA1c 8.2%). Long-acting insulin (glargine) was, therefore, started after discussion with a diabetologist during the preoperative assessment. Carbohydrate loading was not advised before surgery as its role in the perioperative management of patients with diabetes remains controversial. Postoperatively, the blood glucose control was poor despite the use of an intravenous insulin infusion. Preoperative

carbohydrate loading can reduce insulin resistance. It is, therefore, important to determine whether the benefits of preoperative oral carbohydrate loading outweigh the risks in diabetic patients undergoing major bowel surgery.

Discussion

Oral carbohydrate loading and the stress response to surgery

The stress response to surgery causes the production of catabolic hormones [4,5]. These include catecholamines, cortisol, and glucagon, as well as cytokines like interleukin-6 and TNF, all of which can cause insulin resistance on their own. Insulin Resistance (IR) and hyperglycemia are linked to an increased risk of morbidity and mortality following surgery [6]. Chang et al. [7] used an animal model to show diabetes increases the susceptibility to stress. Their study provided critical data on the patterns and features of stress-induced hyperglycemia. These data define the principles for the treatment of patients with diabetes.

Several trials found that preoperative Oral Carbohydrate Supplementation (OCH) decreased postoperative blood glucose, cortisol, and inflammatory markers [8-10]. Mathur et al. [11] conducted a study of preoperative oral carbohydrate loading in two groups of patients undergoing elective major abdominal surgery in New Zealand. An oral glucose load administered the night before surgery and two hours before induction significantly reduced cortisol level on day one after surgery in the group given in comparison to placebo [11].

Widnyana et al. [12] conducted a randomized controlled trial of oral carbohydrate loading in 54 patients aged 16 to 65 having major oncological surgery. The difference between the treatment and control groups was striking. Ingestion of a carbohydrate drink the night before and on the morning of surgery substantially lowered postoperative blood glucose levels [12].

Effectiveness of carbohydrate loading in diabetic patients

Pathophysiological first principles suggest that the preoperative administration of carbohydrate load to patients with inherent insulin resistance is counterintuitive. For example, gastric emptying may be delayed in select patients with diabetes theoretically, although oral carbohydrate loading was found to have no significant risk of aspiration in diabetic individuals [13]. Thus, hitherto, the potential advantages of the ERAS approach in diabetic patients undergoing major surgery have received limited attention. Although the afore mentioned concerns appear to be unwarranted [14], diabetic individuals have, by and large, been omitted from studies of preoperative carbohydrate supplementation.

Yet, such a blanket exclusion has to be reconsidered. Gustaffson et al. [15] investigated carbohydrate loading in 25 patients with type 2 diabetes. They reported that in comparison to healthy volunteers, diabetic patients given a carbohydrate drink had no delay in stomach emptying [15]. Jodlowski et al. [16] found that a preoperative oral carbohydrate load was safe and well-tolerated by diabetic individuals. On the second day after surgery, both diabetic and non-diabetic patients reported increased perioperative well-being, reduced feelings of hunger, and lower plasma insulin concentrations and insulin resistance [16].

Ljungqvist et al. [17] noticed that the insulin resistance index was reduced in diabetic patients who received 200mL of 5% glucose solution 2-3 hours preoperatively comparison to the control group. These observations corroborated those of Jodlowski et al. [16] and [17]. These data indicate that carbohydrate drink given 2-3 hours preoperatively is safe and well-tolerated in patients with diabetes. Furthermore, it has metabolic advantages in patients with diabetes and decreases insulin resistance perioperatively [18].

Oral carbohydrate loading and enhanced recovery after surgery programs

Enhanced Recovery After Surgery (ERAS) is an evidence-based surgical care bundle [4]. It includes several treatments to reduce stress, postoperative complications, and hospital length of stay. Enhanced Recovery protocols, in one form or another, have been used worldwide since 2005 [4]. The fundamental aims of the ERAS concept are to attenuate the metabolic and inflammatory response to surgical stress and reduce insulin resistance [5,19].

A systematic review published by Ge et al. critically appraised the literature prior to 2018 on the safety and efficacy of preoperative oral carbohydrate loading in ERAS protocols for diabetic patients [14]. The authors screened 6238 articles published from 2006-1018 but only identified 5 relevant randomized controlled trials. Analysis of these trials using the Cochrane risk-of-bias tool suggested that the quality of these data was low.

Regardless Ge et al. [14] concluded that preoperative oral carbohydrate is efficacious, reasonable, and realistic for diabetes mellitus patients. Carbohydrate consumption 2-3 hours before surgery can help prevent hypoglycemia from perioperative fasting [14]. It also reduces thirst and hunger before surgery, and prevents the production of excess gastric juices, delayed stomach emptying, aspiration pneumonia, and several other complications of fasting [14].

Oral carbohydrate intake may temporarily raise blood sugar in diabetics. However, there is no evidence that oral carbohydrate loading of diabetics results in hyperglycemia or harmful consequences after the operation [14]. Yet, it is clear that high-quality randomized controlled trials are needed to provide sufficiently robust evidence to support the use of oral carbohydrates in ERAS protocols for diabetes patients [14].

Practical concerns about oral carbohydrate loading of patients with diabetes

Numerous practical concerns surround the implementation of oral carbohydrate loading. Maltodextrin is the main constituent of the currently available drinks used for oral carbohydrate loading. It is reliably excreted from the stomach within two hours. A 50g sachet is commercially available for dilution into 400 ml water, creating a 12.5% energy drink. In many centres, patients receive

100g (2 sachets) the night before the operation and another 50g (1 sachet) 2-4 hours before their operation [18].

It can be difficult to tolerate the ingestion of 800 ml of fluid the night before surgery. This may cause nocturia which is particularly relevant in the context of diabetes mellitus. However, the evening dose is less critical if the patient eats dinner.

The morning dose of carbohydrate is particularly important. This induces the shift from a fasting state to a fed state, reducing insulin resistance. Other issues include the reluctance of patients or staff to violate long-established rules for preoperative fasting. The cost of the intervention is low but not insignificant. Thus, the source of funding can be problematic in some institutions (i.e., pharmacy vs. operating theatre budgets) [18].

Conclusion

Shifting preoperative patients into a 'fed' state helps to modulate the stress response and reduce insulin resistance. Despite good-quality evidence for preoperative carbohydrate loading, it is rarely utilized in patients with diabetes. The currently available data on the preoperative carbohydrate loading of diabetic patients is of poor quality. Thus, the use of carbohydrate loading in diabetic patients remains controversial. So, in this setting, the practice of perioperative physicians varies greatly. More data on the management of the perioperative stress response in diabetic patients is urgently required.

Authors' Contributions

MAR developed the hypothesis. All authors were involved in the literature search and refinement of the hypothesis. MAR prepared the initial draft of the manuscript. All authors were involved with the revision of the manuscript and approved the final version of the manuscript for publication.

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