



Normal Blood Glucose and High Blood Ketones in a Critically Unwell Patient with T1DM Post-Bariatric Surgery: a Case of Euglycemic Diabetic Ketoacidosis

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Abstract

Obesity is a global epidemic. Obesity in those with type I diabetes (T1DM) contributes to poor glycemic control and complications. Bariatric surgery as management for obesity is increasing in those with T1DM. However, there is limited data pertaining to these patients and their potential post-operative complications. These complications include severe hyperglycemia and diabetic ketoacidosis (DKA). This case study describes a 43-year-old woman with T1DM whose post-operative period following her bariatric surgery was complicated by euglycemic DKA. Post-bariatric surgery the incidence of those with T1DM experiencing DKA can be up to 1 in 4. Clinicians should be vigilant of this atypical presentation of DKA to avoid misdiagnosis potentially resulting in delays in treatment. Close monitoring in the post-operative period is warranted.

Keywords Bariatric surgery · Obesity · Type 1 diabetes · Euglycemic diabetic ketoacidosis · Post-operative complications

Introduction

Obesity is a global epidemic. In Australia, approximately 28% of adults are obese [1]. Obesity can increase the risk of individuals experiencing major health comorbidities and management options are limited [1]. Similarly, data indicate a steep rise of obesity in patients with type I diabetes (T1DM) [2]. Bariatric surgery is becoming more common in the management of obese patients including those with T1DM [1, 3]. Australia has seen a greater than threefold rise in the amount of admissions to hospitals for bariatric surgery in recent years [1].

Obesity in T1DM patients can lead to poor glycemic control and the progression of both microvascular and macrovascular complications associated with diabetes [3]. While there is a moderate amount of data pertaining to patients with type 2 diabetes receiving bariatric surgery, there is conversely a lack of data pertaining to patients with T1DM, despite the number of patients with T1DM receiving bariatric surgery increasing [3].

Patients with T1DM often experience improved control of their blood glucose level (BGL) and general management [3]. However, there are also complications specific to this patient group [3]. A small number of studies have concluded that patients with T1DM are at risk of severe hyperglycemia and diabetic ketoacidosis (DKA) in the post-operative period following bariatric surgery [3]. DKA is typically defined by hyperglycemia (> 13.9 mmol/L), elevated serum ketones (> 0.6 mmol/L), and acidosis (pH < 7.3, serum bicarbonate < 18 mEq/L and high anion gap) [4].

This case report describes a patient with known T1DM presenting with euglycemic DKA in the setting of recent bariatric surgery.

Case Study

A 43-year-old woman presented with a 4-day history of dyspepsia and nausea on day 10 post-sleeve gastrectomy. The

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patient was diagnosed at age 20 with T1DM and had been treated with an intensified insulin treatment until 6 months prior to her surgery, when she switched over to continuous subcutaneous insulin infusions (CSII) with a Medtronic insulin pump using insulin lispro. She performed numerous BGL readings per day and occasionally used flash subcutaneous glucose monitoring (Abbott Freestyle Libre). Her associated symptoms included decreased oral intake and vomiting. There were no infective signs or symptoms. The patient had taken numerous BGL readings since her surgery, feeling increasingly unwell on days 4 and 5 post-operatively. The patient had considered the possibility she was experiencing DKA as she had experienced this in the past, however was reassured her BGL readings continuously remained low. She had also checked her insulin delivery on her pump numerous times, which demonstrated it was running correctly. The patient had consumed little carbohydrates as per the dietary advice provided. The patient presented twice to an emergency department during this time, where she had been reassured that her symptoms were related to her surgery. As her condition deteriorated, the patient put her freestyle libre sensor on (flash glucose monitoring) to closely monitor her BGLs. The patient represented to ED a third time as the vomiting increased. At the patient's third presentation to the emergency department, her ketone reading was taken, despite her BGLs remaining below the typical DKA range (below 13.9 mmol/mol) revealing an increased ketone level.

On examination, her heart rate was borderline tachycardic at 100 bpm with all other vital signs being in normal limits. The physical examination was unremarkable. The patient's blood glucose was measured at 11.1 mmol/L and ketones were recorded at 3.9 at the time of admission. Of note, continuous glucose monitoring in the 36 h prior to this showed euglycemic and even hypoglycemic readings. Initial investigations obtained in the emergency department included a venous blood gas demonstrating acidosis with pH 7.26, pCO₂ 31 mmHg, HCO₃ 13 mmol/L, and an elevated beta-hydroxybutyrate of 7.4 mmol/L (<0.5 mmol/L). Other initial blood results obtained in ED were within normal range.

The patient was diagnosed with euglycemic diabetic ketoacidosis, admitted to the critical care unit overnight, and managed as per DKA hospital protocol. The following day, the patient was commenced on her usual insulin regimen via her insulin pump, transferred to the normal hospital ward for further observation, and discharged the next day. It was concluded the patient's euglycemic DKA possibly resulted from the patient's recent sleeve gastrectomy secondary to reduced carbohydrate intake.

Discussion

DKA can be precipitated by a number of etiologies such as infection, acute myocardial infarctions, stroke, and reduced

insulin therapy [4]. A common misconception is that hyperglycemia is essential to the diagnosis of DKA [4]. However, euglycemic DKA was first described in 1973 by Munro et al. proposing severe ketoacidosis in patients with diabetes requiring insulin without marked hyperglycemia can occur secondary to continued insulin regimen in the setting of reduced carbohydrate intake [5]. Munro et al. established this phenomenon through a case series describing 37 episodes of patients presenting with euglycemic DKA [5]. This was explained by continued regular insulin intake despite reduced carbohydrate intake leading to a reduction in gluconeogenesis, thereby facilitating an increased cellular utilization of limited available glucose, resulting in ketoacidosis without hyperglycemia [5]. This may partly explain the mechanism resulting in our patient's presentation, as reduced carbohydrate intake secondary to recent bariatric surgery in the context of continued insulin intake occurred in our patient.

Further case studies have supported the observations of Munro et al. [4]. Case reports of two patients presenting with euglycemic DKA demonstrated similar findings [4]. In these reports, both patients had a period of reduced carbohydrate intake while maintaining their hydration status and regular insulin injections [4]. This is very similar to our patient, who adhered to a modified diet after bariatric surgery with reduced carbohydrate and continued regular insulin while maintaining fluid intake.

There is limited data pertaining to outcomes of patients with T1DM who undergo bariatric surgery [3]. Within this limited research, a collection of cases of DKA occurring in the post-operative period in this group of patients has been documented [3, 6]. A retrospective cohort study was conducted on patients with T1DM collected via a bariatric surgery registry across two hospitals over a 5-year period [6]. This study identified almost 1 in 4 patients had a post-operative period complicated by DKA [6]. In the first 4 weeks post-bariatric surgery, 21.4% of patients experienced an event of DKA [6]. Our patient was day 10 post-sleeve gastrectomy fitting within this post-operative period of increased risk of developing DKA. However, unlike our patient, there were no cases of euglycemic DKA reported in this study. The authors of this study suggested due to dietary changes, vomiting, and development of food intolerances, patients are at risk of developing DKA as well as hypoglycemia [6]. These suggestions are in keeping with our patient who underwent a modified diet post-operatively and experienced episodes of vomiting.

Further, a recent review of the literature pertaining to outcomes of bariatric surgery in patients with T1DM included a total of 17 studies, totaling 107 patients [3]. This review similarly recognized the incidence of post-operative DKA as an adverse event in this patient group [3]. The incidence of post-operative DKA was reported as high as 20–25% in studies included in the review [3]. However, there were no cases

detailed of euglycemic DKA occurring in the patients included in this review [3]. Authors related the incidence of post-operative DKA to factors such as poor oral intake, poor peri-operative insulin adjustment, dehydration, and post-operative infection [3]. While poor oral intake, specifically reduced carbohydrate intake, relate to our patient's presentation other risk factors suggested by the authors in this review did not apply to our patient.

Conclusion

While there is limited data regarding outcomes of T1DM patients who undergo bariatric surgery, the incidence of post-operative DKA in available literature is well documented [3, 6]. Our case highlights the necessity to discuss with patients that DKA occurring without hyperglycemia might occur. Patients and health care professionals need to be aware of this to avoid delays in diagnosis and treatment which had occurred with our patient. Euglycemic DKA is an important diagnostic consideration due to the potential of missed diagnosis in these patients, as it does not present like a typical DKA episode [4]. As the incidence of DKA occurring is up to 1 in 4 of patients with T1DM following bariatric surgery, close monitoring of this patient group is warranted furthermore, ketones as well as

blood gas analysis should be performed on presentation if in doubt [3, 6].

Compliance with Ethical Standards

Ethics Statement Informed consent was obtained from the individual participant included in this study.

Conflict of Interest The authors declare that they have no conflict of interest.

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