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Case Series: Perioperative Euglycemic Diabetic Ketoacidosis in Bariatric Surgery

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BACKGROUND: Euglycemic diabetic ketoacidosis (euDKA) is a rare but serious complication of diabetes, particularly in patients treated with sodium-glucose co-transporter 2 (SGLT2) inhibitors. Postoperative patients, especially those undergoing bariatric surgery, are at elevated risk of euDKA due to perioperative fasting, stress, and variable nutritional intake. This case series highlights three examples of euDKA in the immediate perioperative period.

CASE PRESENTATION: Three patients who underwent sleeve gastrectomy or Roux-en-Y gastric bypass developed euDKA within three weeks. One case occurred intraoperatively, and two presented postoperatively with nausea, vomiting, and metabolic acidosis. Each patient had recently been taking an SGLT2 inhibitor (empagliflozin or dapagliflozin), with variable drug cessation intervals before surgery. All were managed with insulin infusion, IV fluids, and supportive care, resulting in full resolution of acidosis.

DISCUSSION: Our case series highlights the variability in presentation of euDKA in the perioperative setting for bariatric surgery patients. Despite differences in the timing of SGLT2 inhibitor cessation and reinitiation, each patient developed euDKA within a narrow postoperative window, including one case identified intra-operatively. This variability suggests current recommendations for holding SGLT2 inhibitors preoperatively may not fully account for the metabolic stress and abrupt nutritional changes surrounding bariatric surgery. Recognition of euDKA therefore depends not only on adherence to pre-operative guidelines, but also on the possibility euDKA may arise even after these guidelines are followed.

CONCLUSION: Bariatric surgery patients remain vulnerable to euDKA despite standardized preoperative cessation of SGLT2 inhibitors. These cases highlight euDKA is not solely a medication management issue, but a systems challenge that spans surgical care, nutrition, and metabolic oversight. Protocols that integrate preoperative medication cessation, postoperative monitoring, and cautious reinitiation of SGLT2 inhibitors will be essential to reduce risk of euDKA.

Keywords: *Surgery, Case Report, Bariatric Surgery, Diabetes, SGLT2 Inhibitor, Sodium-Glucose Cotransporter-2 Inhibitor, Euglycemic Diabetic Ketoacidosis, Anesthesia*

DISCLAIMER

Information published in this article is not intended to replace clinical judgement or establish a protocol for the care of patients with euglycemic diabetic ketoacidosis. The treatment protocol included in this article is not intended as the sole source of guidance in the management of euglycemic diabetic ketoacidosis, and may not provide the only acceptable approach to the management of this condition. The views expressed in this article are solely those of the authors and do not reflect the views of The Pacific Northwest Journal of Surgery or its Editorial Board.

BACKGROUND

Euglycemic diabetic ketoacidosis (euDKA) is an uncommon but serious complication of diabetes mellitus, defined by the triad of high anion gap metabolic acidosis, ketonemia or ketonuria, and only mildly elevated or normal blood glucose levels. Originally described in the 1970s by Munro and colleagues,[1] euDKA has become increasingly recognized in recent years, particularly with the widespread use of sodium-glucose cotransporter 2 (SGLT2) inhibitors.[2-4] These agents lower plasma glucose by promoting glucosuria, but simultaneously increase the risk of ketone production, predisposing susceptible patients to ketoacidosis even in the absence of significant hyperglycemia. Current Food and Drug Administration (FDA) federal guidance recommends discontinuing canagliflozin, dapagliflozin, and empagliflozin at least 3 days, and ertugliflozin at least 4 days, before scheduled surgery, to reduce the risk of postoperative euglycemic diabetic ketoacidosis.[5]

Beyond medication-related effects, several clinical situations increase vulnerability to euDKA, including surgery, infection, prolonged fasting, and low-carbohydrate diets.[6,7] Bariatric surgery patients are at a heightened risk given perioperative fasting, strict postoperative dietary restrictions, physiologic stress, and increasingly, concomitant use of SGLT2 inhibitors. Although individual case reports and small series have described euDKA after bariatric procedures,[9-12] published data remain sparse.

To address this knowledge gap on euDKA in the bariatric surgical population, we present three cases of euDKA occurring intraoperatively or within three weeks of bariatric surgery.

CASE PRESENTATIONS

Written consent for de-identified publication in the Pacific Northwest Journal of Surgery was provided by all three patients. Review by the local Institutional Review Board was completed (IRB# 29389).

Case No. 1

A 64-year-old man with a body mass index (BMI) of 34 kg/m^2 and American Society of Anesthesiologists (ASA) Class III status underwent a robotic-assisted laparoscopic sleeve gastrectomy, with gastropexy of the gastric staple line to the greater omentum, esophagogastroduodenoscopy (EGD), and concurrent umbilical hernia repair. He had a medical history of obstructive sleep apnea (OSA) treated with continuous positive airway pressure (CPAP) during sleep, New York Heart Association Class I (American College of Cardiology/American Heart Association Stage C) congestive heart failure, with an ejection fraction of 30-35%, with an implantable cardioverter defibrillator (ICD), paroxysmal atrial fibrillation, hypertension, chronic kidney disease, and type 2 diabetes mellitus. His diabetes regimen before surgery included empagliflozin 12.5 mg daily, metformin 1 g nightly, semaglutide 2 mg weekly (held for six weeks preoperatively), intermediate-acting NPH insulin (60 units AM, 90 units PM), and regular insulin (30 units AM). He discontinued empagliflozin 10 days before surgery.

The operative length of time was 128 minutes. Due to his underlying heart disease, an arterial-line catheter was placed for close hemodynamic and chemistry monitoring. Sixty-two minutes into the operation, acidemia was incidentally noted on an arterial blood gas (ABG) panel. The ABG revealed a pH of 7.18, pCO_2 of 40 mmHg, pO_2 of 96 mmHg, and bicarbonate of 15 mEq/L, with concurrent capillary glucose readings between 170–220 mg/dL and beta-hydroxybutyrate (BHB) of 13 mg/dL. Endocrinology was consulted intra-operatively, and patient was started on a titratable regular insulin infusion. Considering the severity of metabolic acidosis, the anesthesia and surgical team elected to continue postoperative ventilatory support for close metabolic management, and the patient was transferred to the intensive care unit (ICU) intubated, and continued on insulin infusion using a standard DKA protocol (with an initial glucose goal range of 200-250 while acidosis resolves, followed by a goal range of 140-180 mg/dL), along with intravenous crystalloid fluids, electrolyte repletion, and hypoglycemia monitoring. He was extubated the same evening, and his anion gap closed within 24 hours.

Although empagliflozin had been stopped 10 days prior, urinalysis showed glucosuria (>500 mg/dL), suggestive of persistent pharmacologic activity. During insulin infusion, his requirement stabilized at 3.8 units/hour (~90 units per day). Given his postoperative clear liquid diet and expected nutritional variability, endocrinology recommended transitioning to basal insulin (glargine 45 units daily) with moderate sliding-scale lispro coverage. His previous regimen of NPH and regular insulin was discontinued, and empagliflozin, metformin, and semaglutide were held, with outpatient endocrinology follow-up to guide reintroduction. The patient was discharged home on postoperative day (POD) 3 in stable condition.

Case No. 2

A 58-year-old woman with a BMI of 45.7 kg/m^2 and insulin-dependent type 2 diabetes, hypertension, hyperlipidemia, asthma, OSA on nightly CPAP, and a history of recurrent small bowel obstruction and abdominal hernias. Her preoperative diabetes regimen included dapagliflozin 10 mg daily, metformin 1 g twice daily, tirzepatide 7.5 mg weekly, and insulin degludec 28 units daily. Dapagliflozin was discontinued 15 days prior to surgery. She experienced hypoglycemic episodes pre-operatively due to dietary instructions, and she discontinued long-acting insulin in response to this. She underwent laparoscopic sleeve gastrectomy with extensive lysis of adhesions, gastropexy, EGD, and bilateral transversus abdominis plane (TAP) block. The procedure lasted 171 minutes. She had an uneventful recovery and was discharged on POD 1 in good condition. She resumed metformin upon discharge, with plans to restart her other medications as tolerated.

On POD 8 she was found at home with altered mental status, and transported to the emergency department, where her venous pH was 6.78, BHB 14.3 mmol/L, serum creatinine 1.35 mg/dL (baseline 0.7 mg/dL), leukocytosis of 24 K/cu mm, and serum glucose 256 mg/dL. She tested positive for COVID, and infectious workup was otherwise negative. On exam she was protecting her airway but was encephalopathic with a Glasgow coma scale (GCS) of 8. Her skin

appeared mottled and she was hypothermic, normotensive, tachycardic, and tachypneic.

The patient was admitted to the ICU for treatment of euDKA. She was treated with intravenous fluids, a regular insulin infusion, and intravenous bicarbonate, and empiric antibiotics. Nasogastric tube nutrition was initiated due dysphagia secondary to encephalopathy. She was stable for transfer to the medical ward after 4 days. Her acidosis completely resolved over the next 2 days, and she was discharged home on hospital day 6 with endocrinology follow-up. Her treatment team decided not to resume SGLT2 inhibitor therapy.

Case No. 3

A 55-year-old woman with a BMI of 42 kg/m^2 and hypertension, hyperlipidemia, type 2 diabetes mellitus, gastroesophageal reflux disease, chronic back pain, and OSA on nightly CPAP underwent laparoscopic Roux-en-Y gastric bypass, lysis of adhesions, bilateral TAP block, and EGD. Her preoperative diabetes regimen included empagliflozin 25 mg daily and insulin via pump. The SGLT2 inhibitor was discontinued one day before surgery and restarted on POD 1 at a reduced dose of 10 mg daily, while insulin therapy was withheld per endocrinology recommendation. The procedure lasted 310 minutes. The Roux limb and biliopancreatic limb were each 100 cm in length. She was discharged on POD 1 in good condition.

She presented to the emergency room on POD 12, reporting four days of nausea, vomiting, and shortness of breath. Laboratory workup revealed an anion gap of 22, serum bicarbonate 5 mEq/L, an arterial pH 7.03 with blood glucose of 189, and BHB of 88.4 mg/dL. She was afebrile, tachycardic, tachypneic, and hypertensive. She was admitted to the medical ICU and treated with intravenous fluids, regular insulin infusion, and bicarbonate replacement. The anion gap closed by hospital day 3, and she was discharged on POD 15 (readmission length of stay approximately 3 days). Her treatment team decided to permanently discontinue empagliflozin.

DISCUSSION

This case series emphasizes that patients undergoing bariatric surgery may be uniquely predisposed to developing euDKA perioperatively. All three cases occurred within three weeks of surgery, suggesting vulnerability in the immediate postoperative time period. Several mechanisms may converge to create this risk: Reduced carbohydrate intake from prescribed pre- and postoperative diets, relative insulin deficiency, surgical stress with associated counterregulatory hormone release, and in some cases ongoing exposure to SGLT2 inhibitors.[2-4,6] Collectively, these factors promote lipolysis and ketone production despite only modest elevations in serum glucose.

Reports in the literature describe similar cases after sleeve gastrectomy and gastric bypass, in which patients present with common postoperative complaints such as nausea, vomiting, or malaise.[9-12] Because blood glucose is not markedly elevated, diagnosis may be delayed and the euDKA may remain unrecognized if clinicians rely solely on hyperglycemia as a trigger for evaluation of DKA. Prompt recognition requires attention to the acid–base profile, calculation of the anion gap, and assessment of serum or urine ketones in patients with unexplained acidosis.

Professional guidelines, such as those from the FDA as well as the American Diabetes Association, recommend withholding most SGLT2 inhibitors at least 3 days before elective surgery (4 days for ertugliflozin).[5,13] Despite this, perioperative continuation or early re-initiation is not uncommon. Enhanced preoperative medication reconciliation, patient counseling, and intra-hospital protocols may reduce risk.[14]

Recently, institutional efforts have focused on developing standardized perioperative management protocols for patients taking SGLT2 inhibitors. Raiten et al. described a multidisciplinary guideline created at a large academic medical center that recommends withholding SGLT2 inhibitors for at least 72 hours before elective surgery, with extended monitoring for metabolic acidosis when this interval is shorter or in urgent cases.[14] The protocol emphasizes perioperative ketone and acid–base assessment, early insulin initiation when indicated, and delayed reintroduction of SGLT2 inhibitors until oral intake and metabolic stability are achieved. Adoption of such structured protocols may reduce the incidence of postoperative euglycemic DKA, particularly among bariatric surgery patients who often experience catabolism and limited oral intake in the early recovery phase.

This case series adds further evidence to the existing literature that euDKA should be considered in the differential diagnosis of postoperative bariatric patients presenting with nonspecific symptoms and metabolic derangements, even when an SGLT2 inhibitor had been appropriately discontinued pre-operatively.

CONCLUSION

Euglycemic diabetic ketoacidosis is a rare but dangerous complication following bariatric surgery. The early postoperative period appears to be particularly high-risk due to overlapping metabolic stressors and dietary restrictions, compounded by SGLT2 inhibitor exposure in some patients.[9-12] Awareness of this entity is essential for timely diagnosis and treatment, as reliance on glucose values alone can be misleading. We recommend that surgeons, endocrinologists, and bariatric multidisciplinary care teams incorporate protocols for SGLT2 discontinuation, close metabolic monitoring, and early consideration of perioperative euDKA in this vulnerable population. Future research should focus on defining the currently-unknown incidence of euDKA in bariatric patients, and refining perioperative management strategies to minimize this risk.

Patient Consent: Written informed consent was obtained from the parents/guardians of all three patients by the authors for publication of this case series in The Pacific Northwest Journal of Surgery. Identifying personal information has been removed. Copies of the written consents are retained by the Journal.

Competing Interests: The authors attest to having no financial or commercial associations that may create conflicts of interest with the information presented in the manuscript.

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Abbreviations: American Society of Anesthesiologists (ASA), beta-hydroxybutyrate (BHB), body mass index (BMI), continuous positive airway pressure (CPAP), diabetic ketoacidosis (EuDKA), esophagogastroduodenoscopy (EGD), euglycemic diabetic ketoacidosis (EuDKA), Food and Drug Administration (FDA), Glasgow coma scale (GCS), implantable cardioverter defibrillator (ICD), intensive care unit (ICU), obstructive sleep apnea (OSA), postoperative day (POD), sodium-glucose cotransporter2 (SGLT2), transversus abdominis plane (TAP).

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