CLINICAL REVIEW

Diagnosis and Management of Post-Bariatric Hypoglycemia

Helen M. Lawler, MD, Timothy McGinnis, MD, and Mary-Elizabeth Patti, MD

With 1 in 8 people worldwide living with obesity, bariatric procedures continue to increase in popularity with more than a half million surgeries performed yearly. Postbariatric hypoglycemia (PBH) is now recognized as a complication of bariatric and upper gastrointestinal surgeries. While prevalence remains uncertain, symptoms have been reported in up to 30% of postsurgical patients. PBH is characterized by postprandial hypoglycemia causing neuroglycopenic symptoms of confusion, loss of consciousness, and seizures in a smaller subset of patients. Patient symptoms are often falsely attributed to other more common medical conditions due to the nonspecific nature of symptoms and lack of recognition of this complication, contributing to a frequent delay in diagnosis for many years. Our narrative review provides a summary of how to diagnose PBH, distinction of PBH from dumping syndrome, and detailed evidence-based guidance on selecting treatment. We also present the most up-to-date research involving the pathophysiology of PBH. Our goal is to raise awareness of how to diagnose and treat PBH as prompt diagnosis can lead to early treatment intervention to reduce hypoglycemic episodes and potentially decrease the development of hypoglycemia unawareness. (J Am Board Fam Med 2025;38:383–394.)

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Introduction

Metabolic and bariatric surgery is now a relatively common procedure for weight loss with approximately 600,000 cases performed worldwide in 2021.[1] Postbariatric hypoglycemia (PBH) can occur after Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), and other bariatric procedures which alter upper gastrointestinal anatomy, resulting in rapid transit of nutrients into the intestine. Thus, PBH is not typically observed after gastric banding. Postprandial hyperinsulinemic hypoglycemia can also occur after other upper gastrointestinal procedures and surgeries such as fundoplication, esophagectomy, and gastrectomy.[2] Symptom onset typically occurs at least 1 year postoperatively, and hypoglycemic episodes are usually postprandial, occurring 1 to 3 hours after meals, especially meals containing simple carbohydrates. Patients may experience symptoms that are adrenergic (palpitations, tremulousness, anxiety), cholinergic (diaphoresis, paresthesia, hunger), and/or neuroglycopenic (confusion, slurred speech, blurred vision, weakness, dizziness, seizure, coma).[3–5]

The advantages of metabolic and bariatric surgery for treatment of obesity are vast including improvement and potential resolution of comorbidities such as type 2 diabetes mellitus, hypertension, and obstructive sleep apnea as well as reduced cardiovascular disease, cancer, and mortality.[6] Thus, the benefits of surgery usually outweigh the potential risk of developing PBH. However, it is important to quickly recognize and treat PBH as neuroglycopenia and the development of hypoglycemia unawareness can lead to poor quality of life, falls, motor vehicle accidents, seizures, loss of consciousness, and other neurological consequences.

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From the Division of Endocrinology, Metabolism, and Diabetes, Department of Medicine, University of Colorado School of Medicine, Aurora, CO (HML); Division of General Internal Medicine, Department of Medicine, University of Colorado School of Medicine, Aurora, CO (TM); Joslin Diabetes Center, Harvard Medical School, Boston, MA (MEP).

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Corresponding author: Helen M. Lawler, MD, 1635 Aurora Court, Room 6600, Stop F-732, Aurora, CO 80045 (E-mail: helen.lawler@cuanschutz.edu).

Prevalence

The prevalence of PBH remains uncertain and is potentially underestimated due to hypoglycemia unawareness that can occur with repeated hypoglycemia, and the nonspecific nature of symptoms which may be erroneously attributed to other conditions such as menopause, anxiety, or arrhythmias. Further complicating assessment is the frequent lack of concordance between symptoms and glucose levels, and variable accuracy of methods used to detect hypoglycemia.[7] In a recent meta-analysis, the rate of PBH detected via continuous glucose monitoring was 54%, often without symptoms.[8] By contrast, symptoms of hypoglycemia have been reported in approximately 1/3 of patients with history of RYGB or SG.[4] Another study evaluating hypoglycemia induced by a mixed meal tolerance test found 48% of patients 4 years after RYGB experienced blood glucose levels below 3.3 mmol/L (60 mg/dL).[9] By contrast, episodes of hypoglycemia requiring hospitalization have been estimated to occur rarely in <1% of patients.[10] Higher risk populations are those with history of preoperative symptoms, younger age at time of surgery, RYGB surgery, female sex, no history of diabetes, greater weight loss, treatment with SSRI/SNRI medications, and prior cholecystectomy.[9,11–13] There is a continuum of symptom severity, and it is currently unknown why some patients develop recurrent neuroglycopenia and others have more mild disease.

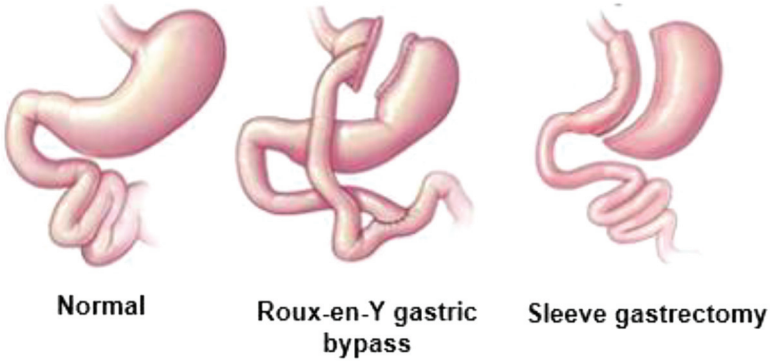
Pathophysiology

PBH is a consequence of anatomic and physiologic changes occurring after upper gastrointestinal surgery. To date, SG and RYGB are the most frequently performed bariatric surgical procedures.[1] With RYGB, a small proximal gastric pouch is created and attached to the jejunum; food therefore bypasses the remaining stomach, duodenum, and the first 40 to 50 cm of the proximal jejunum, instead rapidly transiting to the remainder of the jejunum. This results in an earlier and higher glucose peak.[14] With SG, the stomach is reduced to approximately 20 to 25% of its original volume, reducing gastric expansion and thus resulting in rapid transit of nutrients to the duodenum. Figure 1 depicts the anatomic changes created with SG and RYGB. The surgically transformed anatomy and altered delivery of food to the intestine results in rapid absorption of meal nutrients and increases in plasma glucose, contributing to excessive insulin release from pancreatic β cells.[14]

Insulin secretion after meals is further accentuated by release of the incretin hormone, glucagon-like peptide-1 (GLP-1), from intestinal neuroendocrine L-cells.[14] Postprandial GLP-1 levels are markedly increased in patients after bariatric surgery as compared with those who have not undergone surgery and are even higher in most patients with PBH.[14–16] When glucose levels are high, elevated incretin levels stimulate even greater insulin secretion, leading to marked hyperinsulinemia.[15–18] In support of the role of GLP-1 in the pathophysiology of PBH, research studies have demonstrated that blockade of the GLP-1 receptor can ameliorate postprandial hypoglycemia in patients with PBH.[19,20]

Yet, the pathophysiology of PBH is complex and multifactorial involving more mechanisms than solely changes in GLP-1 physiology. Other insulin-dependent mechanisms contributing to PBH include

Figure 1. Anatomy before and after the 2 most common bariatric procedures. Anatomy of the normal upper gastrointestinal tract (left) and after Roux-en-Y gastric bypass and sleeve gastrectomy.



decreased pancreatic β-cell suppression in response to hypoglycemia and reduced insulin clearance.[14,21] In addition, increased serotonin levels,[22] altered bile acid metabolism,[23–25] altered microbiome,[26–28] reduced counterregulatory hormones in response to hypoglycemia,[21,29,30] increased proinflammatory signaling,[32] and intestinal upregulation of glucose transporters[33] have also been found to contribute to PBH pathophysiology (Figure 2). However, a key central and consistent phenotype is inappropriately high release of insulin in the postprandial state resulting in hypoglycemia.

Clinical Presentation

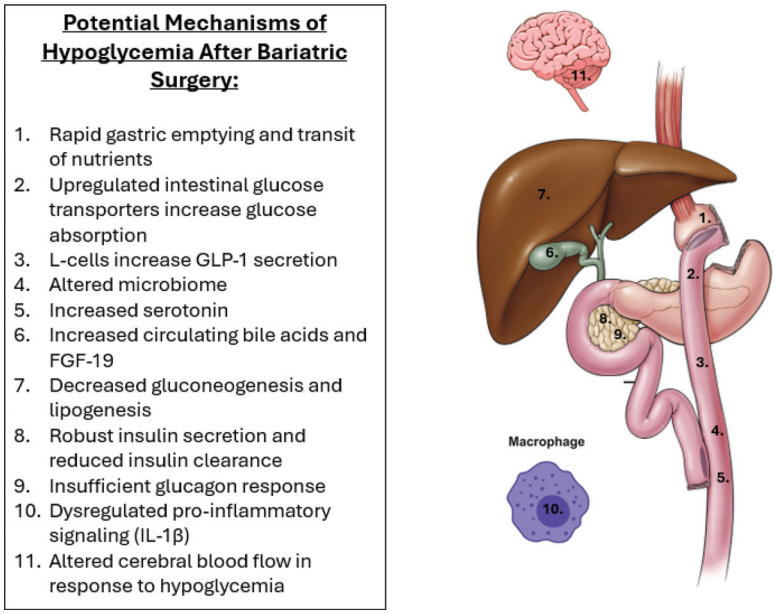
Symptoms of hypoglycemia are diverse and can be broadly classified as adrenergic (eg, palpitations, tremor, anxiety), cholinergic (eg, sweating, hunger, paresthesia), or neuroglycopenic (eg, fatigue, confusion, difficulty speaking, weakness, dizziness, blurred vision, coma).[34] Given that these symptoms are nonspecific, it is essential to establish the presence of Whipple's triad to make a diagnosis of hypoglycemia: 1) symptoms of hypoglycemia, 2) confirmed low blood glucose during symptoms (preferably venous blood samples), and 3) improvement of symptoms with correction to normoglycemia.[34]

PBH should be suspected if hypoglycemic symptoms occur 1 to 3 hours postprandially, particularly after meals heavy in simple carbohydrates. It is important to note that patients who experience recurrent hypoglycemia may develop reduced awareness of hypoglycemia, with fewer or no symptoms over time. If patients do not experience adrenergic or cholinergic warning symptoms, the first signs may instead be neuroglycopenic symptoms of confusion, altered mental status, seizures, or coma.

Distinction of Post-Bariatric Hypoglycemia (PBH) from Dumping Syndrome

PBH is distinct from early dumping syndrome. Early dumping results from rapid transit of food and liquids causing osmolar shifts and sympathetic nervous system activation.[35] Symptoms and signs of early dumping include dizziness, flushing, palpitations, nausea/vomiting, diarrhea, tachycardia, and hypotension, usually within 15 to 60 minutes after eating.[36] Blood glucose is normal or even elevated when patients experience early dumping syndrome. Moreover, dumping syndrome usually occurs shortly after surgery and often resolves a few months after surgery, as opposed to PBH which typically occurs more than 6 months after surgery and does not resolve. "Late dumping syndrome" has also been used to describe PBH, but this has led to confusion and is considered obsolete terminology. "Reactive hypoglycemia" has been used to describe patients with postprandial hypoglycemia but is sometimes also used to

Figure 2. Potential mechanisms contributing to the pathogenesis of postbariatric hypoglycemia.



describe patients with hypoglycemic symptoms without hypoglycemia. As a result, there has been advocacy to use the term "dumping syndrome" solely to refer to early dumping syndrome, use PBH instead of late dumping syndrome, and use idiopathic postprandial syndrome to describe patients with symptoms of hypoglycemia without confirmed hypoglycemia.[35,37,43]

Assessment and Diagnosis

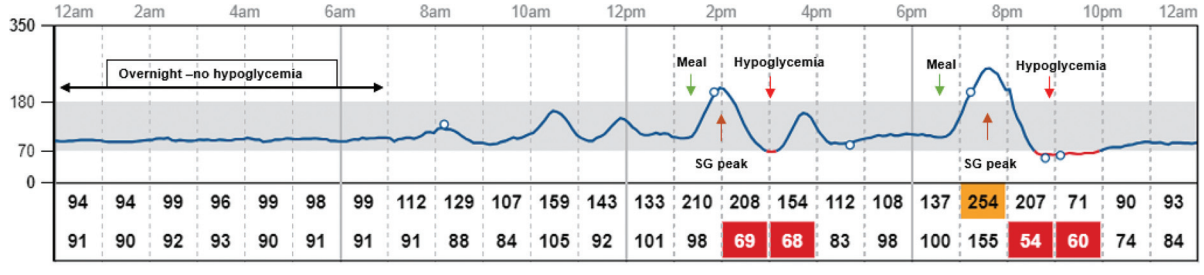
PBH is diagnosed by clinical presentation, detailed medical history, establishment of Whipple's triad (as noted above) and general laboratory evaluation. History should focus on determining whether additional medications or supplements, alcohol, undernutrition, or coexisting systemic medical conditions or hormonal disorders (eg, adrenal insufficiency) could be aggravating hypoglycemia. The timing of hypoglycemia should be elicited, as PBH occurs primarily postprandially and occasionally is worsened by activity. Glycemic patterns revealed by either self-monitoring of blood glucose (SMBG) or continuous glucose monitoring (CGM) include frequent rises in glucose to frankly hyperglycemic levels after meals, especially meals heavy in simple carbohydrates, followed by a rapid drop to hypoglycemic levels (Figure 3). A mixed meal tolerance test (MMTT) is not often needed to confirm the diagnosis but can be helpful in cases with a less clear presentation by demonstrating the typical glucose excursions and insulin hypersecretion seen in PBH. An oral glucose tolerance test (OGTT) is not recommended as the glucose load can cause significant dumping syndrome and places patients at risk for hypoglycemic seizures; moreover, OGTT can induce hypoglycemia in 25% of healthy individuals without a history of upper gastrointestinal surgery, leading to false diagnoses.[38] If hypoglycemia is occurring primarily in the fasting state or occurs within 6 months after surgery, this is not typical for PBH and a full endocrine evaluation including prolonged fasting testing is recommended to rule out insulinoma (Figure 4).[37,39–41] Approximately 95% and 100% of patients with insulinoma will have fasting hyperinsulinemic hypoglycemia after a 48 hour fast and 72-hour fast, respectively[41]; by contrast patients with PBH will not have fasting hyperinsulinemic hypoglycemia unless they also have an insulinoma or other disorder of insulin secretion.

Imaging is typically not needed in the evaluation of PBH, unless biochemical evaluation reveals evidence of autonomous insulin secretion. If dumping syndrome symptoms are prominent and/or weight regain has occurred, endoscopic evaluation of GI surgical anatomy could be considered to assess for potential revision of the gastrojejunal anastomosis.

Continuous Glucose Monitoring (CGM)

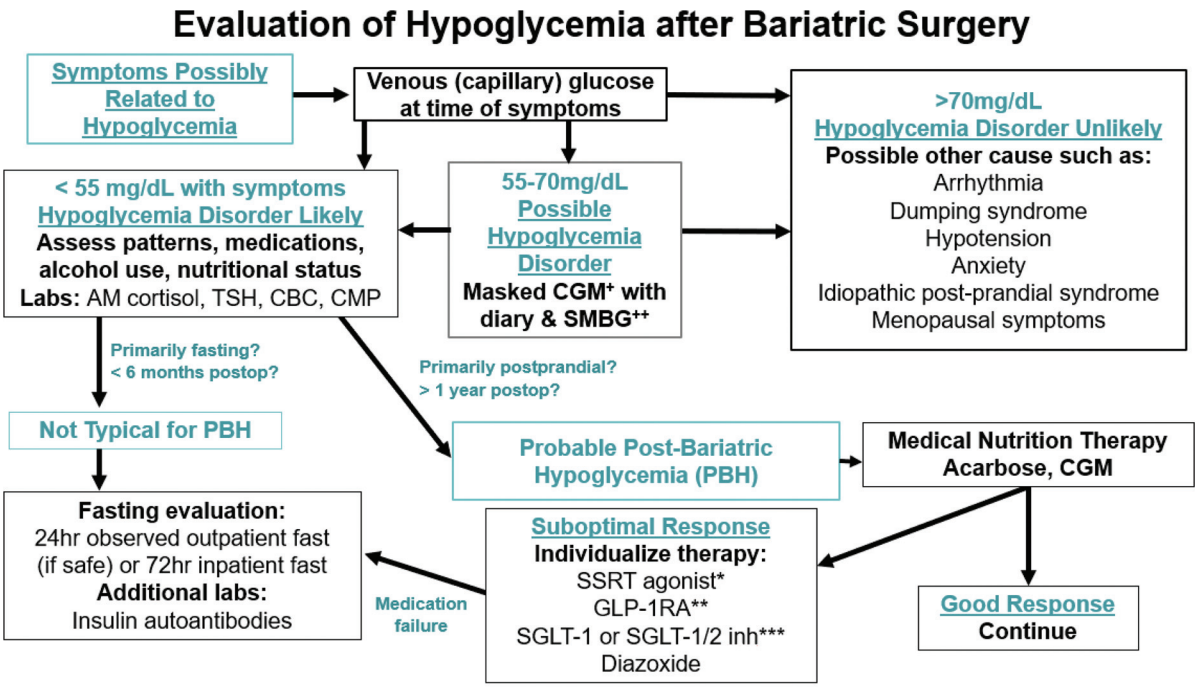
We do not recommend using CGM to diagnose hypoglycemia, as sensor glucose values are not as accurate as venous or capillary glucose in low ranges and may yield falsely low values. CGM may overestimate the occurrence of PBH in patients after RYGB; for example, Kefurt et al reported that a mixed meal tolerance test resulted in serum glucose < 55 mg/dL in 29% of individuals, while a 5-day CGM showed low sensor glucose 75% of the time in the same patients.[31] Despite the lack of utility of CGM to make a diagnosis, CGM is important for monitoring and can help patients with PBH recognize precipitating factors, timing, patterns, and "trigger foods" and thus reduce glycemic spikes,

Figure 3. Typical continuous glucose monitoring (CGM) pattern in a patient with postbariatric hypoglycemia.



Note: Postprandially, there are episodes of sensor glucose (SG) elevation followed by a rapid decline in blood glucose as depicted on this CGM download. Overnight hypoglycemia is rare. Note that we do not recommend use of CGM for diagnosis, but for pattern recognition by the clinician and patient.

Figure 4. Clinical approach to possible postbariatric hypoglycemia.



Note: CGM+ = continuous glucose monitoring, SMBG++ = self-monitoring of blood glucose, SSRT agonist* = somatostatin receptor agonist, GLP-1RA** = glucagon-like peptide-1 receptor agonists, SGLT-1 or SGLT-1/2 inh*** = sodium glucose cotransporter 1 or 1/2 inhibitors.

reduce hypoglycemia, and improve glucose variability.[42,43] The alarms for hypoglycemia and rapidly declining glucose are especially helpful in improving safety for those who have developed hypoglycemia unawareness. Unfortunately, insurance coverage for CGM use in this patient population can be difficult to obtain despite evidence of significant benefits.

Treatment

Dietary Modification

Dietary modification is the mainstay treatment of PBH, with the goal of reducing the stimulus for insulin secretion after meals. Medications to reduce the frequency and severity of hypoglycemia may be required for cases unresponsive to dietary modification.

Patients with PBH should adhere to eating meals high in protein and with controlled portions of carbohydrates, particularly avoiding high glycemic index or quickly digested simple carbohydrates.[44–46] Adherence to meals containing not more than 30 g of carbohydrates was shown to prevent hypoglycemia in a clinical trial of 14 patients with PBH[45] and to significantly reduce hypoglycemic episodes and hypoglycemic events requiring another person's assistance in an additional trial of 41 patients.[46] Liquids should not be consumed with meals or within 1 hour after eating to avoid further acceleration of gastric emptying. Consultation with an experienced registered dietician is encouraged.

Overview of Pharmacotherapy

There is currently no Federal Drug Administration-approved medication for treating PBH. However, if dietary modifications are ineffective, off-label pharmacotherapy can be used as an adjunct (Table 1). Pharmacotherapy which has been used for treatment of PBH includes acarbose, somatostatin receptor agonists, calcium channel blockers, diazoxide, GLP-1 receptor agonists (GLP-1RA) and SGLT-1/2 or SGLT-2 inhibitors.[47–50] To date, there has only been 1 randomized crossover study to investigate comparative effects of different medications for management of PBH after RYGB, using mixed meal tolerance test and CGM. Treatment with acarbose and pasireotide improved nadir glucose levels and reduced time in hypoglycemia during a MMTT

Table 1. Pharmacotherapy for Treatment of Post-Bariatric Hypoglycemia

Class of Medication	Mechanism of Action	Dosing	Side Effects	Cost**	Sort*
Alpha-glucosidase inhibitors	Slows glucose absorption in the intestine	Acarbose or miglitol 25 mg orally 20 minutes before meals, uptitration as tolerated (maximum of 300 mg daily)	Abdominal pain Bloating Diarrhea Flatulence	$ (~$20 for 90 tabs)	B
Uncooked cornstarch	Complex carbohydrate that is very slowly absorbed	1 to 3 tablespoons mixed with water, sugar-free beverage, or food given 2 to 3 times daily	Abdominal pain Bloating Flatulence	$ (~$3 for 16 oz container)	C
GLP-1 agonists	Mechanism of action in PBH is uncertain Slows gastric emptying, increases satiety, stimulates glucose-dependent insulin release, reduces glucagon release	Start with lowest dose and uptitrate as needed	Constipation Decreased appetite Diarrhea Nausea Vomiting Weight loss	$$$ (4 pens ~$900)	B
SGLT-2 and SGLT-1/SGLT-2 inhibitors	SGLT-2 inhibitors (SGLT2i) - inhibit the coupled reabsorption of sodium and glucose from the proximal tubules SGLT-1 inhibitors (SGLT1i) - reduction in intestinal glucose absorption	**SGLT2i:** Empagliflozin 25 mg daily **Dual SGLT1/2i:** Canagliflozin 300 mg daily (SGLT-1 effect only at 300 mg dose) Sotagliflozin 200 mg daily	Euglycemic DKA Urinary tract infections Yeast infections Dehydration	$$$ (30 tabs ~$300)	B
Somatostatin analogs	Inhibit incretin and insulin secretion	Octreotide: 50 to 200 μg SQ 2 to 3 times daily, or monthly LAR formulation Lanreotide 90 to 120 mg every 4 weeks Pasireotide: 60 to 90 μg SQ 1 to 2 times daily	Cholelithiasis Diarrhea QTc prolongation Reduced cortisol secretion Steatorrhea Worsening of hyperglycemia	$$$ (120 vials of 100 μg $400)	B
Activator of ATP-sensitive potassium channels (non-diuretic benzothiadiazine derivative)	Inhibits pancreatic insulin release Increases hepatic glucose production	Diazoxide 50 to 100 mg orally twice daily	Fluid retention Hypotension Nausea	$$ (50 mg/mL, one 30 mL bottle $100)	C

*Based on Strength of Recommendation Taxonomy (SORT), **Pricing from GoodRx as of November 2024.

whereas sitagliptin, verapamil, and liraglutide had no effect.[50] In addition, acarbose reduced peak glucose levels and time in hyperglycemia whereas pasireotide significantly increased both variables.[50] None of the treatments had an impact on CGM-derived low sensor glucose metrics, but acarbose and liraglutide reduced hyperglycemia and glycemic variability.[50]

A recent retrospective study of 120 patients evaluated the efficacy and side effects of medical therapy with acarbose, diazoxide, short-acting and long-acting octreotide, GLP-1RA, and surgical treatment of PBH in daily practice.[51] Overall, medical therapy showed 45% to 75% efficacy with combined therapy used in 25%; long-acting octreotide and GLP-1RA had the greatest percent reduction in hypoglycemia.[51] From the patients' perspective, GLP-1RA was the preferred treatment as it had the fewest side effects and highest adherence and diazoxide was the least favored treatment with the highest number of side effects.[51]

Acarbose

Acarbose or miglitol, inhibitors of α-glucosidase, are usually the first-line pharmacologic choice, starting with 25 mg 20 minutes before the largest meal daily, up-titrating slowly before each meal containing carbohydrates and as tolerated to a maximum of 300 mg/day.[52,53] Slow up-titration is recommended to assist with reducing side effects. α-glucosidase enzymes in the brush border of the intestine release glucose from ingested carbohydrates. Thus, inhibition of these enzymes with acarbose or miglitol slows the digestion of complex carbohydrates and thus reduces postprandial hyperglycemia. By reducing postprandial hyperglycemia, patients with PBH will have a reduction in postmeal insulin secretion, the ultimate driver of subsequent hypoglycemia. Small clinical trials have supported the efficacy of acarbose in reducing PBH.[51–53] Unfortunately, acarbose/miglitol therapy is often not tolerated due to side effects such as bloating, gas, and abdominal discomfort, especially when carbohydrate intake remains high.

Uncooked Corn Starch

Although limited to small case reports, uncooked corn starch (30 to 55 g), mixed with water or food before meals and/or before bedtime, reduced hypoglycemic episodes. Thus, cornstarch should be considered as an adjunct to medical nutrition therapy, particularly if acarbose is stopped due to side effects or lack of efficacy.[54] If acarbose or uncooked corn starch are not tolerated or ineffective, referral to an endocrinologist is recommended for reevaluation of the diagnosis and for initiation of more complex therapies detailed below.

Somatostatin Receptor Agonists

Somatostatin receptor agonists such as octreotide, lanreotide, and pasireotide inhibit incretin and insulin secretion and may be considered for second line therapy if a patient has failed acarbose. Octreotide 50 to 100 mcg before meals reduced dumping syndrome and hypoglycemia[55] whereas pasireotide led to overall hyperglycemia in 2 trials and reduction in hypoglycemic events in 1 of the 2 trials.[50,56] Unfortunately, the use of somatostatin receptor agonists is often limited by cost as well as potential side effects of QTc prolongation, cholelithiasis, diarrhea, and reduced cortisol secretion.

Glucagon-like Peptide Receptor Agonists (GLP1-RA)

A systematic review and the above-mentioned retrospective study have suggested effectiveness of GLP1-RA to reduce glycemic variability and hypoglycemia in PBH and demonstrated patient therapeutic preference.[51,57] Many patients with PBH have experienced weight regain so the weight loss that can occur with GLP-1RA therapy is appealing.

The mechanism by which GLP-1RA reduces hypoglycemia in PBH is unknown.[58] Possibly, the continuous GLP-1 receptor activation provided by GLP-1RA reduces response to meal-stimulated increases in native GLP1 and thus diminishes postprandial hyperinsulinism or the decreased appetite also helps patients to reduce meal intake of provocative foods. Potential side effects of GLP-1RA include weight loss, decreased appetite, nausea, vomiting, and constipation. Contraindications include personal or family history of medullary thyroid cancer or multiple endocrine neoplasia syndrome type 2 (MEN 2). Some patients develop worsening hypoglycemia with GLP-1RA therapy; we recommend evaluation to assess nutritional adequacy and to exclude autonomous insulin secretion before initiation of therapy or if hypoglycemia is worsened by therapy, as insulinomas have abundant GLP1 receptors.[59]

Diazoxide

Diazoxide inhibits pancreatic insulin release and increases hepatic glucose production and can be effective in low doses. It is approved by the Federal Drug Administration for treatment of hyperinsulinism but has not been extensively studied in PBH, in which data

are limited to case reports.[60] As mentioned previously, diazoxide tolerance can be limited by side effects including fluid retention, hypotension, and nausea. Thus, diazoxide may be considered in patients who have failed other agents or when insurance coverage is a limiting factor.

Calcium Channel Blockers

Due to lack of efficacy in the randomized crossover study mentioned above,[50] calcium channel blocker therapy is not typically chosen as a primary therapy.

SGLT-1 and SGLT-1/2 Inhibitors

Treatment of PBH with SGLT1/2 (canagliflozin) or SGLT-2 inhibitors (empagliflozin) has shown mixed results.[61–64] Empagliflozin increased glucose levels in patients with PBH more so than in a non-PBH surgical control group yet did not affect nadir glucose during a mixed meal tolerance test in one study[62] and reduced glucose excursions but not hypoglycemia in individuals with PBH in another study.[63] Canagliflozin inhibits SGLT-2 at lower doses but inhibits both SGLT-2 and SGLT-1 at doses of 300 mg daily. A pilot study of canagliflozin 300 mg daily in patients with PBH after RYGB significantly reduced peak plasma glucose and insulin levels during OGTT compared with baseline and reduced the frequency of glucose levels < 50 mg/dL from a baseline of 95.2% to 9.5% with canagliflozin.[64] The authors attributed the improved glucose to canagliflozin-induced SGLT-1 inhibition (ie, delayed glucose absorption in the small intestine) during the first 2 hours of the OGTT as opposed to the SGLT-2 effect (ie, urinary glucose excretion) which occurs after 2 hours.[64] Sotagliflozin, another SGLT 1/2 inhibitor has not yet been studied in PBH. If pursuing a trial of SGLT-2 therapy, patients should be counseled about the risk of euglycemic DKA and told to avoid ketogenic diets. Clinical trials are ongoing to further evaluate canagliflozin and to evaluate mizagliflozin, a selective SGLT-1 inhibitor, as a potential treatment for PBH.

Cost of Pharmacotherapy

Over the counter corn starch is the most affordable option for patients. In addition, acarbose is inexpensive and usually covered by insurance. It is often difficult to obtain insurance approval for GLP-1 agonists, SGLT-2 or 1/2 inhibitors, or octreotide due to high costs and insurance companies are not willing to cover expensive medications for off-label use. Diazoxide, although often the last agent utilized, is usually covered by insurance and affordable for patients. A summary of cost is provided in Table 1.

Pharmacotherapy in Development

Additional approaches for management of PBH are in development. Anakinra, an IL-1α and IL-1β antagonist, reduced hypoglycemia in 1 study.[32] Phase II trials showed efficacy of a GLP-1 antagonist, avexitide, to reduce hypoglycemic episodes.[19] Mini-dose glucagon delivered via pump also reduced the severity of hypoglycemic episodes without rebound hyperglycemia.[65] In addition, self-administration of dasiglucagon over a 4-week period reduced clinically relevant hypoglycemia in 24 patients with PBH.[66] These are important advancements but will require additional studies in larger populations to fully evaluate efficacy.

Surgical Procedures

If both intensive dietary modification and medications are ineffective, more invasive procedures can be considered. Transoral outlet reduction (TORe) endoscopic suturing system is an option to reduce the size of the gastrojejunal anastomosis when increased diameter may be contributing to dumping symptoms or PBH; a case series demonstrated reduction in postprandial hypoglycemia after TORe in 11 patients with refractory hypoglycemia after RYGB.[67,68] Resolution of hypoglycemia has also been reported with long-term complete enteral nutrition via gastrostomy or jejunostomy tube (no oral feedings).[69] RYGB reversal has variable efficacy in resolution of hypoglycemia; one review reported improvement in postprandial hypoglycemic symptoms in 42/48 (88%) of patients after reversal.[70,71] Before pursuing reversal, some have recommended testing the efficacy of enteral feeding via gastrostomy tube placed in the remnant stomach to assess the potential effectiveness of RYGB reversal in resolving hypoglycemia, but this may not be fully diagnostic.[72] Unfortunately, reversal of SG is not possible, and conversion to RYGB may worsen hypoglycemia. Partial pancreatectomy is not recommended unless there is a coexisting insulinoma, due to the high morbidity of this procedure and high rates of recurrence of hypoglycemia.[70,73]

Treatment of Acute Hypoglycemic Episodes

Lastly, it is important to provide patient education on how to treat acute hypoglycemia due to PBH as

treatment differs from hypoglycemia that occurs in patients without PBH on insulin or insulin secretagogues. A large bolus of simple sugar could lead to hyperglycemia and subsequent rebound hypoglycemia creating a "yo-yo" effect on blood sugars. Thus, we recommend patients use 10 g of simple sugar (ie, dextrose), recheck blood sugar in 15 minutes, re-treat if needed, and then follow treatment with a food containing protein and fat (ie, cheese stick, spoonful of unsweetened peanut butter). In addition, it is important to provide education to patients taking acarbose that honey, milk, or dextrose tablets should be used for rescue as acarbose will slow the digestion of sucrose. All patients should be provided prescriptions for glucagon rescue. A medical alert bracelet is recommended and driving precautions are provided if hypoglycemic episodes are frequent.

Prognosis

Research is needed to assess the long-term effects of recurrent neuroglycopenia on the cognition, morbidity, and mortality of patients with PBH. A recent small study examined cognitive function in individuals with PBH after RYGB compared with individuals without hypoglycemia after RYGB and found that individuals with PBH had significantly greater cognitive impairments compared with those without PBH.[74] Although many patients have resolution of hypoglycemic episodes with dietary intervention and/or pharmacotherapy, some do not. Research is underway to understand why many patients never develop PBH and others develop severe refractory cases after bariatric and other upper gastrointestinal surgery.

Conclusion

As the prevalence of obesity and the number of bariatric procedures continue to rise, the incidence of PBH will likely continue to increase. PBH can have a significant negative impact on quality-of-life, ability to maintain a job, capacity to operate a motor vehicle, and capability to live independently; in the smaller subset of patients with frequent severe neuroglycopenia, PBH can be dangerous and life-threatening. Thus, it is important to have a low threshold of suspicion for PBH and provide early diagnosis and management in this patient population.

Key Points for Practice

1. Post-bariatric hypoglycemia (PBH) causes neuroglycopenic symptoms due to post-prandial hyperinsulinemic hypoglycemia. Fasting hypoglycemia (upon arising) is not typical for PBH and should prompt investigation for another cause of hypoglycemia (insulinoma, adrenal insufficiency, side effects of medications, liver/kidney disease, etc.).
2. Diagnosis of PBH can be made by patient history and confirmation of Whipple's triad. Sensor glucose (CGM) is not adequate for diagnosis of hypoglycemia but can be helpful in depicting typical PBH patterns of post-prandial hyperglycemia followed by subsequent hypoglycemia. An oral glucose tolerance test is not recommended to diagnose PBH as this could cause hypoglycemic seizures in this patient population.
3. It is best to avoid the terminology, "reactive hypoglycemia". There is advocacy to use "dumping syndrome" to refer to early dumping syndrome, to use "post-bariatric hypoglycemia" as opposed to "late dumping syndrome", and to use "idiopathic postprandial syndrome" to describe patients with hypoglycemic symptoms after eating but without confirmed hypoglycemia.
4. Dietary modification (i.e. mixed meals high in protein, < 30 g of carbohydrate per meal, avoiding all simple sugars) is the mainstay treatment of PBH with the goal of reducing the stimulus for insulin secretion after meals. There is currently no Federal Drug Administration approved medication for treating PBH. If initiating pharmacotherapy, we recommend first trying low dose acarbose and uptitrating the dose as tolerated, together with cornstarch. If acarbose is not tolerated or ineffective, we recommend referral to an endocrinologist for further evaluation.
5. Treatment of acute hypoglycemia from PBH requires 10g of simple sugar, recheck of glucose in 15 minutes, retreat if needed, and then subsequent treatment with a food containing protein and fat (i.e. cheese stick, spoonful of unsweetened peanut butter). If the patient is taking acarbose, honey, milk, or dextrose tablets should be used for rescue as acarbose will slow the digestion of sucrose. All patients should be provided prescriptions for glucagon rescue.

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