

Post-Op Bariatric Surgery — Learn How to Identify Red Flags and Triage Nutritional Deficiencies

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Obesity is a complex, multifactorial disease that has genetic, biological, and environmental origins. While traditional treatment has involved counseling individuals to restrict calories and make lifestyle changes, such as eating a nutrient-dense diet, participating in regular physical activity, and other behavior modifications, many people classified as severely obese (BMI of 40 or greater) are still unable to lose and maintain significant weight loss.

In the United States, more than one-third of adults aged 20 and older are classified as being obese (BMI of 30 or greater).¹ It's been estimated that the rate of severe obesity is rapidly increasing. Between 2000 and 2005, obesity rates rose 24%; the obesity rates among those with a BMI of 40 or greater and a BMI of 50 or greater have risen by 50% and 75%, respectively.²

These climbing rates show traditional weight-loss modalities have failed to provide long-term solutions. In fact, studies have found that bariatric surgery is the only modality that leads to permanent, significant weight loss and the reduction of comorbidities for the vast majority of individuals who have severe obesity.³⁻⁸ These results appear to be the impetus for the growing popularity of bariatric surgery. In 2009 alone, it was estimated that 220,000 people underwent bariatric surgery,⁹ and as Medicare and private insurance companies increasingly provide reimbursement for these procedures, these numbers may grow.

Because more and more people are choosing weight-loss surgery, it will be of greater importance for dietitians to educate themselves about the different types of bariatric procedures and how to care for the unique nutritional needs of these patients.

This continuing education course will discuss the various bariatric surgical procedures as well as the most common nutritional deficiencies in patients before and after surgery and strategies to treat them.

Need for Nutrition Guidelines

With the ever-increasing prevalence of bariatric surgery, a greater need for evidence-based nutrition guidelines is apparent. More dietitians are asking questions about the procedures and how to effectively counsel patients. Many RDs are seeing bariatric surgery patients for the first time in their practices and may not fully understand the procedures or what are appropriate questions to ask clients. The good news is that there are guidelines RDs and other healthcare professionals can follow.

In 2008, the American Society for Metabolic and Bariatric Surgery (ASMBS) published allied health nutrition guidelines for bariatric surgery patients who have undergone Roux-en-Y gastric bypass, adjustable gastric banding, and biliopancreatic diversion (BPD) with and without duodenal switch.¹⁰ The ASMBS plans to update these guidelines to include a discussion of the gastric sleeve procedure, an increasingly popular bariatric surgical technique. Until then, health professionals should rely on the latest reports in the scientific literature for guidance.¹¹

Types of Procedures

The bariatric procedures performed in the United States fall under the terms “restrictive,”¹² “malabsorptive,” or a combination of both. There’s a movement within some bariatric societies to change the description of bariatric surgeries from restrictive or malabsorptive to “metabolic surgery,” but the traditional classification method is what’s prevalent. Therefore, this article will use the terms restrictive and malabsorptive to describe these procedures.

Purely Restrictive

This surgical technique involves adjustable gastric banding. The adjustable gastric band is a silicone band placed near the top of the stomach to decrease gastric capacity and assist in reducing solid food intake. Individuals who eat large portions of food at mealtimes may benefit the most from this procedure. Those who continuously snack throughout the day, however, may not benefit because they’re more likely to eat unhealthful foods, such as crackers, pretzels, and ice cream that can easily slide through the band, preventing them from sustaining long-term weight loss.

The vertical sleeve gastrectomy procedure, also known as “the sleeve,” involves the removal of approximately 80% of the stomach, including the fundus, where the body makes 90% of the chief hunger hormone called ghrelin. A decrease in ghrelin may cause a reduction in hunger for approximately six months after surgery. Some experts perceive this procedure as purely restrictive in nature, while others consider it “mainly restrictive”¹³ because of the significant decrease in stomach acid that can predispose patients to micronutrient deficiencies, such as vitamin B₁₂.

Unlike the Roux-en-Y gastric bypass and the BPD with or without duodenal switch, the sleeve doesn’t involve the small intestines, making it a more restrictive procedure. The sleeve also doesn’t involve bypassing the duodenum, although there are reports that it can cause vitamin and mineral deficiencies, which may be due to the decrease in the production of intrinsic factor. But long-term data (greater than five years) is lacking. Evidence shows there are additional hormonal changes following the sleeve procedure, including an increase in the release of the gut hormones peptide YY and glucagonlike peptide-1, which impact hunger and satiety.

The sleeve was originally designed to be the initial surgery for high-risk patients and people with a BMI greater than 50. Once these patients lose a significant amount of weight, reducing the risks associated with more complex procedures, they would then undergo BPD or BPD with duodenal switch, or the Roux-en-Y gastric bypass.^{14,15} The sleeve technique recently was introduced as a stand-alone bariatric procedure because the short-term outcomes of weight loss and positive impact on comorbidities were significant. The sleeve also decreases the risk

of micronutrient deficiencies and associated complications linked with the Roux-en-Y gastric bypass and BPD procedures.¹⁶

Restrictive Malabsorptive

Roux-en-Y gastric bypass is a restrictive-malabsorptive technique considered the “gold standard” for weight-loss surgery in the United States.¹⁷ Following this procedure, gastric capacity is reduced by 90% to 95%. The section of the gastrointestinal tract bypassed is called the biliopancreatic limb, which includes the majority of the stomach, the duodenum, and part of the jejunum. This limb drains bile, digestive enzymes, and gastric secretions to assist digestion and absorption further down the alimentary tract.

During surgery, the proximal to midend of the jejunum is anastomosed to the gastric pouch. Less commonly, the distal end of the jejunum is anastomosed to the gastric pouch for greater malabsorption. This creates the common limb. After gastric bypass surgery, the food and enzymes ingested are mixed only in the small area of the common limb, compromising absorption of certain nutrients.¹⁸

Many in the medical community believe macronutrients are malabsorbed after gastric bypass surgery as they are with the BPD or BPD with duodenal switch procedure, while others say this isn't the case. Primarily, research shows that micronutrients are malabsorbed following gastric bypass surgery, leading to micronutrient deficiencies in patients.

Malabsorptive

The BPD with or without duodenal switch comprises this category of bariatric surgery. Each has only a minimal restrictive component that involves the creation of a sleeve-like stomach.

In 1976, Professor Nicola Scopinaro of Italy introduced the BPD procedure, which involved the creation of a 200- to 500-mL proximal gastric pouch and removal of 60% to 75% of the stomach to reduce food capacity. The creation of a 200- to 300-cm alimentary limb with a 50-cm common channel resulted in fat malabsorption due to the diversion of biliopancreatic secretions into the distal ileum.^{19,20} To lower the risk of fat malabsorption and other side effects, the BPD with duodenal switch was introduced. DeMeester and Hinder^{21,22} were the first to describe this modified technique for the treatment of severe duodeno-gastric reflux.

The potential advantages of BPD with duodenal switch over Roux-en-Y gastric bypass include a decreased incidence of marginal ulceration, vagal innervation, and the preservation of antropyloric function, which reduces the risk of dumping syndrome as seen in at least 50% of Roux-en-Y gastric bypass patients.²³ Although many people define dumping syndrome as vomiting or diarrhea, it more likely resembles common symptoms associated with hypoglycemia, such as dizziness or lightheadedness, sweating, nausea, and lethargy, which may last 30 to 60 minutes or longer. Many people report feeling lethargic and/or nauseated for several hours but this varies. Dumping syndrome is believed to occur in about 50% of gastric bypass patients who eat too quickly, drink with meals, or consume concentrated sugars or too much protein at one time (eg, protein supplements containing 60 g of protein in one serving). The absence of the pylorus and pyloric valve as well as the duodenum prevent the body from

diluting concentrated foods and may be a significant factor in the occurrence of dumping syndrome.

Common Post-Op Micronutrient Deficiencies

Bariatric procedures that involve techniques to reduce gastric capacity or reroute the intestines to the gastric pouch may lead to micronutrient deficiencies. Micronutrients are malabsorbed following gastric bypass surgery and BPD with or without duodenal switch. It's estimated that BPD with or without duodenal switch can cause a 25% decrease in protein absorption and a 72% reduction in fat absorption.¹⁰ Vitamins and minerals that depend on fat absorption for optimal bioavailability, such as vitamins A, D, E, and K and zinc, won't be fully absorbed. Moreover, the delay in gastrointestinal transit time may increase the risk of many other micronutrient deficiencies, including iron, calcium, vitamin B₁₂, and folate.¹⁰

But micronutrient deficiencies not only affect postsurgery patients; they can affect severely obese individuals known for their high intake of macronutrients.⁴ For example, a patient seeking adjustable gastric banding surgery may present with many vitamin and mineral deficiencies that can be exacerbated after surgery.¹⁰ Purely restrictive procedures, such as gastric banding, may result in micronutrient deficiencies related to changes in dietary intake or vomiting.

The following are some of the most common micronutrient deficiencies and symptoms patients experience after bariatric surgery and strategies for treatment.

Thiamin

Vitamin B₁, also called thiamin or thiamine, is one of eight B vitamins that assist the body in converting food (carbohydrates) into fuel (glucose) and is used to produce energy for the body.¹⁰ Thiamin and the B complex vitamins assist in fat and protein metabolism and proper functioning of the brain and nervous system and are essential for healthy skin, hair, eyes, and liver.¹⁰

Bariatric surgery can exacerbate or increase the risk of thiamin deficiency and lead to beriberi, a disease caused by a lack of thiamin. Patients at high risk of developing beriberi include those who have preexisting thiamin deficits, low nutrient intake, had a malabsorptive bariatric procedure, or have episodes of chronic nausea and vomiting. Early diagnosis of signs and symptoms is extremely important. Gastric banding patients also may be at risk, particularly if they experience intractable vomiting because thiamin has a short half-life, meaning that thiamin stores last only a few days in the body.

Untreated thiamin deficiency may lead to Wernicke's encephalopathy, a syndrome characterized by visual abnormalities such as nystagmus and lid ptosis, ataxia, peripheral neuropathy, memory loss, confusion, apathy, disorientation and, in some cases, death. IV infusions of thiamine with dextrose are recommended to treat patients with thiamin deficiency.¹⁰

Symptoms of thiamin deficiency include burning feet, neuropathy, and chronic vomiting. Treatment can involve patients taking B-50 complex vitamins, 300 to 400 mg of total elemental

magnesium for maximum thiamin absorption and appropriate neurological function, 20 to 30 mg/day of oral thiamin to address early symptoms of neuropathy, and 50 to 100 mg/day of thiamin administered intravenously or intramuscularly for more advanced signs of neuropathy or protracted vomiting.¹⁰

Exercise caution with magnesium supplementation greater than 490 mg/day since this may cause diarrhea. Moreover, magnesium supplements may be contraindicated in patients with chronic kidney disease.

Vitamin B₁₂

Like other B vitamins, vitamin B₁₂ plays an integral role in metabolism and helps manufacture red blood cells and maintain the central nervous system.¹⁰

A vitamin B₁₂ deficiency is defined as a level below 200 pg/mL. Gastric bypass patients don't fully digest or absorb vitamin B₁₂ from protein foods, which puts them at high risk of deficiency. The amount of stomach acid produced in the new stomach pouch is significantly low. Stomach acid is needed to release vitamin B₁₂ from protein foods. It's unclear if or how much intrinsic factor is produced in the new pouch after gastric bypass surgery or in the sleeve following the sleeve procedure. Intrinsic factor binds with B₁₂ in the duodenum for absorption in the lower intestines.

A vitamin B₁₂ deficiency is uncommon among gastric banding patients because they have complete use of their stomach.¹⁰ Furthermore, vitamin B₁₂ deficiency isn't as prevalent in patients who had BPD with duodenal switch because they don't have as great a restriction in stomach capacity and hydrochloric acid-producing parietal cells as gastric bypass patients.¹⁰

In a prospective, randomized study comparing gastric banding vs. gastric sleeve patients at one and three years post-op, Himpens and colleagues found a 10% to 26% prevalence of vitamin B₁₂ deficiency among gastric sleeve patients that wasn't observed in gastric banding patients.²⁴

Other factors that increase the risk of vitamin B₁₂ deficiency include a vegan diet¹⁰; the reduction of intrinsic factor associated with the sleeve and gastric bypass procedures; anticonvulsant agents; medications such as neomycin, metformin, and colchicines; and proton pump inhibitors used to treat bowel inflammation, gastroesophageal reflux disease, and ulcers.²⁵

It's important to recognize that approximately 50% of patients with obvious signs and symptoms of deficiency have normal B₁₂ levels²⁶—that is, approximately one-half of all patients with normal vitamin B₁₂ levels per standard lab range for normal may be vitamin B₁₂ deficient. Therefore, it's important for RDs to recommend all postsurgery patients get tested annually for vitamin and mineral deficiencies, and RDs should tell their patients' primary care doctors which micronutrients must be measured.

Symptoms of vitamin B₁₂ deficiency include numbness and tingling in the fingers and hands (paresthesias); macrocytic anemia, a group of anemias marked by low hemoglobin levels,

larger-than-normal red blood cells, and an increased mean corpuscular volume and mean corpuscular hemoglobin; and pernicious anemia (found in the late stages of deficiency).

Treatment includes patients taking 700 to 2,000 mcg/week of vitamin B₁₂, with the deficiency usually resolving after several weeks.²⁷ To ensure absorption, it's recommended vitamin B₁₂ be taken sublingually, intranasally, or as an injection.

Folic Acid

Folic acid is a vital B vitamin involved in red blood cell production and cell growth. It's particularly important before and during pregnancy to help prevent birth defects such as spina bifida, a debilitating and fatal congenital disease. Adequate folic acid supplementation also helps decrease the risk of macrocytic anemia.

Some causes of a folic acid deficiency include inadequate dietary intake, nonadherence with multivitamin and mineral supplementation, malabsorption, medications such as anticonvulsants, oral contraceptives, and cancer treatment agents.²⁵ It's important to note that folic acid stores can be depleted within a few months post-op unless replenished by multivitamin and mineral supplements and dietary sources.¹⁰

The gastric sleeve, although less invasive than the gastric bypass or BPD procedures, may result in a higher risk of folate deficiency. The study by Gehrer showed that 22% of gastric sleeve patients were low in folic acid postsurgery.¹³ According to another study, normal levels were restored when patients received a daily 1-mg folic acid supplement.¹³

Symptoms of folic acid deficiency include fatigue, weakness, headaches, difficulty concentrating, palpitations, diarrhea, and a red, painful tongue in the early stages leading to a smooth, shiny surface in the chronic deficiency stages.

Treatment includes one daily multivitamin providing 200% of the Daily Value (800 mcg) or 1 mg/day of folic acid.²⁸ Supplementation greater than 1 mg/day isn't recommended because of the potential for masking vitamin B₁₂ deficiency.²⁹ Note that if a patient has a normal folic acid test but a deficiency is still suspected, suggest a serum blood test for homocysteine, the most sensitive marker of folic acid status.²⁹

Iron

Iron is vital for the production of red blood cells and is involved in various metabolic processes, including DNA synthesis, and oxygen and electron transport.

Research suggests a high risk of preoperative anemia exists among patients with severe obesity and female bariatric surgery patients of childbearing age due to heavy menstrual periods.¹⁰

Iron deficiency often is seen among bariatric surgery patients who have undergone gastric bypass or BPD with or without duodenal switch. These procedures can lead to iron malabsorption and a reduced intake of iron-rich foods such as meat, pork, chicken, turkey, and liver. Vitamin C can enhance absorption of dietary and supplemental iron sources as can

cooking foods in a cast iron skillet.³⁰ The gastric sleeve also may result in iron deficiency due to lower acid content in the stomach. One study showed a 10% incidence of iron deficiency in patients three years post-op.²⁴

Symptoms of iron deficiency include a constant craving for ice (pagophagia); a craving for and consumption of nonfood materials such as paper, dirt, clay, cornstarch, or paint; pallor and increased shortness of breath with new-onset deficiency (unknown etiology); dark circles under the eyes; lethargy; and spoon-shaped nails (koilonychia).¹⁰

Treatment includes two multivitamins for male and female adolescents and menstruating adult women postsurgery. Adolescents and adults may require a total of 50 to 100 mg of elemental iron per day, though the long-term efficacy of this treatment is unknown.³¹ Low-risk patients postsurgery can take two multivitamins with minerals that contain 18 mg each of iron. IV iron infusion is recommended for patients who can't tolerate oral supplementation.

Calcium and Vitamin D

Calcium and vitamin D deficiency may be prevalent before and exacerbated after bariatric surgery due to lower gastric acidity, particularly among gastric bypass patients. Since vitamin D is dependent on a low pH environment in the stomach for optimal absorption, it's imperative to test patients' vitamin D levels pre- and post-op so they can be treated quickly and avoid developing metabolic bone disease, hypertension, and diabetes. The following are additional facts about calcium and vitamin D:

- Vitamin D facilitates calcium absorption in an acidic environment.
- Low vitamin D levels are associated with a decrease in dietary calcium absorption.¹⁰
- Parathyroid hormone is considered a better calcium measure than serum calcium. An elevated level suggests suboptimal calcium adherence and/or absorption.³²
- In patients with severe obesity, there's an increased prevalence of vitamin D deficiency.³²
- Given the low-acidic environment in gastric bypass patients, absorption of calcium carbonate is poor.
- Calcium citrate is better absorbed than calcium carbonate even among nonbariatric surgery patients, regardless of whether they had an empty stomach or a meal.³³ Since calcium citrate doesn't depend on a low pH or acidic environment in the stomach for optimal absorption and calcium carbonate does, the latter isn't as well absorbed after bariatric surgery. In addition, many bariatric surgery patients take acid blockers for three to six months after their procedure to help lower the risk of ulcers, further decreasing the acidity in the stomach or pouch in gastric bypass patients.

Vitamins A, E, and K and Zinc

Fat-soluble vitamins such as vitamins A, E, and K haven't been extensively studied in the context of bariatric procedures, but research suggests there's a risk of deficiencies among patients who have undergone BPD with and without duodenal switch.

Among patients who underwent BPD with or without duodenal switch, researchers found a decrease in intestinal dietary fat absorption related to the delay in the mixing of gastric and pancreatic enzymes with bile in the final 50 to 100 cm of ileum. BPD was shown to decrease fat absorption by as much as 72%.³⁴

Zinc is a mineral that helps maintain the immune system and is associated with cell division, cell growth, wound healing, and carbohydrate metabolism. Hair loss within the first six months following surgery is common and most often associated with telogen effluvium triggered by rapid weight loss and the stress of surgery on the body. Called "shedding," this hair loss has no association with nutrition needs in the uncomplicated post-op patient, so dietitians should be cautious about recommending additional mineral supplementation during this stage. However, a zinc deficiency may also exacerbate hair loss. Research has shown that BPD and gastric bypass patients are more likely to be at risk of zinc deficiency. One study found that 34% of gastric sleeve patients experienced a deficiency postsurgery.¹³ Dietitians should consider screening any bariatric patient experiencing hair loss beyond six months post-op for zinc deficiency.

Clinicians should be aware that excessive zinc supplementation, which may occur with hair and nail formulas, especially in addition to what is in the multivitamin/mineral supplement, may increase the risk of copper deficiency. Furthermore, patients who are zinc deficient may experience a metallic taste in their mouths and hair loss on the arms, legs, and groin area.

Copper

Copper is another important mineral that hasn't been studied extensively in bariatric surgery patients despite the fact it's absorbed by the stomach and proximal gut. This has particularly important ramifications for patients who had gastric bypass or BPD with duodenal switch procedures.¹⁰ A copper deficiency can cause anemia and myelopathy, decreased myelin in the spinal cord that may diminish function of the upper or lower extremities, similar to symptoms associated with a vitamin B₁₂ deficiency.¹⁰

Two cases of copper deficiency have been reported in gastric bypass patients, both presenting with ataxia (altered gait) and paresthesias.^{35,36} Copper status needs to be examined in gastric bypass and BPD with duodenal switch patients presenting with signs and symptoms of neuropathy with normal vitamin B₁₂ levels.³⁷

Symptoms of copper deficiency include paresthesias and ataxia. Since zinc supplementation may decrease copper stores and/or exacerbate copper deficiency, patients should be aware of zinc hair or nail supplements without copper, especially long-term use of high-dose zinc supplements.¹⁰

Treatment is a multivitamin containing 2 to 4 mg/day of elemental copper, depending on the patient's deficiency level.¹⁰

Overcoming Postsurgery Challenges

Dietitians working with bariatric surgery patients play an integral role in their care and long-term success. It's common for these patients not to feel hungry within the first six months after surgery, particularly after gastric bypass, BPD with and without duodenal switch, and gastric sleeve procedures, because the hormones that regulate hunger cues have been dramatically altered. Gastric banding patients may or may not feel physically hungry after surgery, but typically they become hungry within a few weeks, since ghrelin levels may increase due to lower oral intake. The following strategies can help patients stimulate their hunger cues and sense of taste, and prevent nausea that often follows surgery:

- Suggest patients set an alarm clock or timer on their mobile phone to remind them to eat and drink.
- Have clients freeze lemon or lime wedges and suck on them to relieve nausea, which is associated with dehydration, a common issue within the first few months following bariatric surgery as patients may fear drinking too quickly, not be thirsty, or forget to carry water with them. Typical bariatric surgery center recommendations suggest patients avoid drinking fluids with meals and wait 30 minutes after meals before resuming fluid intake. RDs should especially educate patients who take diuretic medications about the signs and symptoms of dehydration.
- Recommend clients add a lemon or lime wedge, grated ginger, or diluted juice to water or a calorie-free, noncarbonated, decaffeinated beverage and place it in the freezer until it reaches a slushy consistency. Drinking this slushy may help alleviate nausea and increase overall fluid intake. Since ice is less dense than water, it will be easier for bariatric patients to tolerate.
- Ask patients what protein-rich foods they're eating and determine whether they're getting enough. The recommended daily intake of protein is 60 to 80 g or 1 to 1.5 g/kg of ideal body weight. Protein deficiency is less common in patients who have had gastric bypass, the sleeve, and adjustable gastric banding procedures; however, it's a concern in those who have undergone BPD with or without duodenal switch.¹⁰

To ensure patients get the protein they need, advise them to drink an unflavored or savory protein supplement, such as egg white protein powder (available at natural food stores) or chicken soup-flavored whey protein isolate powder (available online from bariatric surgery supplement manufacturers) if foods tend to taste sweet. Unflavored whey or soy protein powders are available at pharmacies, natural foods stores, and online. Vegan patients and those who want to avoid whey or soy due to allergies or intolerances can drink hemp and other high-quality vegan protein powders, such as reinforced pea protein (available online).

It's important to ensure these are complete in high-biological protein, which should be mentioned on the label as a high PDCAAS, which stands for protein digestibility corrected amino acid score. The PDCAAS assesses the presence of indispensable amino acids (formerly known as essential amino acids) as well as the digestibility of the protein. A PDCAAS of 100 represents a high-quality protein supplement.¹⁰

- Suggest patients drink liquid or powdered vitamin/mineral supplements (available online from bariatric surgery vitamin companies) and add them to water or low-calorie, noncarbonated beverages.

Because vomiting may become an issue after bariatric surgery due to nausea, dehydration, or postoperative medications, it should be treated immediately, especially in light of potential deleterious effects of an untreated thiamin deficiency.¹⁰ Chronic vomiting is a red flag that requires further investigation. In these cases, dietitians should ask patients which beverages and foods are they eating and what behaviors are they practicing that may be causing the vomiting. Patients who are anxious or stressed while eating may develop intolerance to certain foods, so it's important to remind them to avoid drinking beverages with meals to improve tolerance.

- Sialorrhea, or excessive salivation, may be perceived as vomiting, but it could be related to eating too quickly, too much at once, or dry foods.

Because bariatric surgery involves complex procedures that often rearrange the anatomy of the digestive system various complications and deficiencies in the fat-soluble vitamins, vitamin B₁₂, iron, calcium, and folate can occur in addition to decreases in protein and fat absorption. These realities plus the growing prevalence of obesity and weight loss surgery in the United States make it more important now than ever for dietitians to familiarize themselves with the different procedures available and the most common nutritional deficiencies associated with each of them. Becoming knowledgeable about the intricacies of weight loss surgery and the nutritional issues involved will help dietitians better counsel and treat patients as they embark on the long road to recovery.

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Calculating Weight-Loss Goals

Weight-loss expectations for patients who have undergone bariatric surgery are calculated in the surgical literature as a percentage of their excess weight, whereas in the medical literature a percentage of initial weight is used to calculate goals. If dietitians use a BMI of 25 as a goal for patients to reach, they can calculate excess body weight loss if they know the patient's height and initial weight on the day of surgery.

For example, for a patient who's 5-feet 6-inches tall to achieve a BMI of 25, she should weigh 155 lbs. So if her initial weight was 355 lbs, she started with 200 lbs of excess weight. If her

lowest weight was 255 lbs after surgery, that number would be her excess body weight loss at her lowest point. The patient lost 100 of the 200 lbs of excess weight, or 50% of her excess weight. Typically, this would be considered a good result for adjustable gastric banding and vertical sleeve gastrectomy procedures since the patient was well within an average weight loss. However, this is considered a suboptimal weight loss result for both the Roux-en-Y gastric bypass and biliopancreatic diversion (BPD) with or without duodenal switch procedures.

In 2004, Buchwald and colleagues¹ published a meta-analysis on the mean percentage of excess weight loss among common bariatric procedures. The sleeve technique wasn't widely performed in the United States at that time, so it wasn't included in the study. The researchers reported that the mean percentage of excess weight loss was 47.5% in patients who had gastric banding; 61.6% in those who had gastric bypass; and 70.1% in patients who underwent BPD and BPD with duodenal switch.

Although surgical centers may differ on how to calculate excess weight loss (eg, some use a BMI of 25 as an ideal body weight while others use insurance tables), 70% excess weight essentially translates into a weight loss of 70 lbs for every 100 lbs patients have to lose. Evidence shows weight loss is greatest among patients who had BPD or BPD with duodenal switch procedures.

One study compared BPD with duodenal switch with gastric bypass in patients considered "superobese" (BMI of 50 or greater). After 12 months post-op, the number of patients who regained 10% of their weight loss (standard for many patients from their lowest weight after surgery) was greater in those who had gastric bypass than those who underwent BPD with duodenal switch. BPD patients lost 84 lbs for every 100 pounds they had to lose, while gastric bypass patients lost 64 lbs for every 100 lbs of excess weight.²

Other studies show that nearly 50% of patients who had gastric banding were considered failures five or more years after surgery. A failure was defined as poor weight loss (eg, less than 30% of their excess weight or less than 30 lbs lost for every 100 lbs of excess weight) or the need to have the band removed.³

It's common for patients to regain 10% to 15% of their initial excess weight loss, even with gastric bypass surgery. However, regaining more than this may be a sign the patient hasn't changed his or her lifestyle habits or isn't managing stress or other environmental challenges well. A patient who loses 100 lbs and regains even 20 lbs after a sleeve procedure is considered one who experienced a greater-than-average weight loss.

Dietitians can help prevent patients from gaining additional weight by educating them about diet and physical activity, the importance of adequate sleep, and stress management.

— MMF

References

1. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA*. 2004;292(14):1724-1737.
2. Topart P, Becouarn G, Ritz P. Weight loss is more sustained after biliopancreatic diversion with duodenal switch than Roux-en-Y gastric bypass in superobese patients. *Surg Obes Relat Dis*. 2012;Epub ahead of print.
3. Spivak H, Abdelmelek MF, Beltran OR, Ng AW, Kitahama S. Long-term outcomes of laparoscopic adjustable gastric banding and laparoscopic Roux-en-Y gastric bypass in the United States. *Surg Endosc*. 2012;26(7):1909-1919.

Questions to Ask Post-Op Surgery Patients

When working with bariatric surgery patients, it's important to ask them questions during their postoperative visit that can help determine whether they're at risk of developing vitamin and mineral deficiencies. The following are the most common questions dietitians should ask:

- **Are you having any problems seeing at night?** If the answer is yes, the RD should recommend the patient get screened for vitamin A deficiency, as this is typically the first sign and symptom after biliopancreatic diversion (BPD) with duodenal switch and gastric bypass surgery.
- **Do you have any numbness or tingling in your hands or feet?** New-onset numbness may be related to the surgery, although chronic numbness may be linked to diabetes if this was a preexisting issue for the patient. However, numbness that worsens in patients with diabetes could be a sign of a deficiency in vitamin B₁₂, thiamin, or copper, depending on the area of numbness.
- **Have you experienced any burning in your feet?** This may be a symptom of a thiamin deficiency. The numbness or burning, erythema, or redness in the feet will travel upward from the feet to the calves to the knees. The numbness can progress from the toes to the entire leg within hours and may be potentially life threatening. So if an RD suspects a thiamin deficiency, he or she should refer the patient to a medical provider for immediate treatment.
- **Have you been forgetful lately?** If the answer is yes, the patient could be deficient in vitamin B₁₂ or thiamin or have low blood glucose levels. Carbohydrate goals for patients could be the following: a minimum of 70 g three months post-op, 100 g six months post-op, and 130 g one year post-op.

General guidelines are available to help lower the risk of ketosis and other side effects related to suboptimal carbohydrate intake, such as metabolic bone disease or the exacerbation of bone disease after bariatric surgery. In addition, patients with inadequate carbohydrate intake may not be able to engage in regular physical activity

due to chronic lethargy. Patients may complain they're experiencing "brain fog," possibly related to chronic inadequate carbohydrate intake, so RDs should encourage adequate consumption of fresh fruits, vegetables, and whole grains long term for bariatric surgery patients.

- **Have you experienced vomiting or a foamy/white discharge coming from your mouth after eating?** This may be a symptom of sialorrhea, or "sliming," vs. true vomitus. Sliming is a term sometimes used by the lay public to describe the white foamy discharge resulting from eating too quickly or consuming too much. This typically subsides or disappears when the patient begins to consume moist foods, eats slowly, and avoids drinking with meals.
- **Have you felt unsteady on your feet lately?** This could be a symptom of a deficiency in thiamin, copper, or vitamin B₁₂.

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References

1. Ogden CL, Carroll MD, McDowell MA, Flegal KM. Obesity among adults in the United States—no statistically significant change since 2003-2004. *NCHS Data Brief*. 2007;(1):1-8.
2. Sturm R. Increases in morbid obesity in the USA: 2000-2005. *Public Health*. 2007;121(7):492-496.
3. Sjöström L, Lindroos AK, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med*. 2005;351(26):2683-2693.
4. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA*. 2004;292(14):1724-1737.
5. Buchwald H, Williams SE. Bariatric surgery worldwide 2003. *Obes Surg*. 2004;14(9):1157-1164.
6. Maggard MA, Shugarman LR, Suttorp M, et al. Meta-analysis: surgical treatment of obesity. *Ann Intern Med*. 2005;142(7):547-559.
7. Solomon CG, Dluhy RG. Bariatric surgery—quick fix or long-term solution? *N Engl J Med*. 2004;351(26):2751-2753.
8. Livingston EH. Obesity and its surgical management. *Am J Surg*. 2002;184(2):103-113.
9. American Society for Metabolic & Bariatric Surgery. ASMBS 2010 annual meeting overview (new studies). <http://asmbs.org/2012/06/asmbs-2010-annual-meeting-overview-new-studies>. June 22, 2010.

10. Allied Health Sciences Section Ad Hoc Nutrition Committee, Aills L, Blankenship J, Buffington C, Furtado M, Parrott J. ASMBS allied health nutritional guidelines for the surgical weight loss patient. ***Surg Obes Relat Dis***. 2008;4(5 Suppl):S73-S108.
11. Mechanick JI, Kushner RF, Sugerman HJ, et al. American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. ***Obesity (Silver Spring)***. 2009;17(1 Suppl):S1-70.
12. Tucker ON, Szomstein S, Rosenthal RJ. Nutritional consequences of weight-loss surgery. *Med Clin North Am*. 2007;91(3):499-514.
13. Gehrler S, Kern B, Peters T, Christoffel-Courtin C, Peterli R. Fewer nutrient deficiencies after laparoscopic sleeve gastrectomy (LSG) than after laparoscopic Roux-Y gastric bypass (LRYGB)—a prospective study. ***Obes Surg***. 2010;20(4):447-453.
14. Nguyen NT, Longoria M, Gelfand DV, Sabio A, Wilson SE. Staged laparoscopic Roux-en-Y: a novel two-stage bariatric operation as an alternative in the super-obese with massively enlarged liver. ***Obes Surg***. 2005;15(7):1077-1081.
15. Cottam D, Qureshi FG, Mattar SG, et al. Laparoscopic sleeve gastrectomy as an initial weight-loss procedure for high-risk patients with morbid obesity. ***Surg Endosc***. 2006;20(6):859-863.
16. Hakeam HA, O'Regan PJ, Salem AM, Bamehriz FY, Eldali AM. Impact of laparoscopic sleeve gastrectomy on iron indices: 1 year follow-up. ***Obes Surg***. 2009;19(11):1491-1496.
17. Shankar P, Boylan M, Sriram K. Micronutrient deficiencies after bariatric surgery. ***Nutrition***. 2010;26(11-12):1031-1037.
18. Alvarez-Leite JI. Nutrient deficiencies secondary to bariatric surgery. ***Curr Opin Clin Nutr Metab Care***. 2004;7(5):569-575.
19. Scopinaro N, Gianetta E, Civalleri D, Bonalumi U, Bachi V. Biliopancreatic bypass for obesity: II. Initial experience in man. ***Br J Surg***. 1979;66(9):618-620.
20. Scopinaro N, Adami GF, Marinari GM, et al. Biliopancreatic diversion. ***World J Surg***. 1998;22(9):936-946.
21. DeMeester TR, Fuchs KH, Ball CS, Albertucci M, Smyrk TC, Marcus JN. Experimental and clinical results with proximal end-to-end duodenojejunostomy for pathologic duodenogastric reflux. ***Ann Surg***. 1987;206(4):414-426.
22. Hinder RA. Duodenal switch: a new form of pancreaticobiliary diversion. ***Surg Clin North Am***. 1992;72(2):487-499.

23. Flancbaum L, Belsley S, Drake V, Colarusso T, Tayler E. Preoperative nutritional status of patients undergoing Roux-en-Y gastric bypass for morbid obesity. **J Gastrointest Surg.** 2006;10(7):1033-1037.
24. Himpens J, Dapri G, Cadière GB. A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years. **Obes Surg.** 2006;16(11):1450-1456.
25. Charney P, Malone AM. **ADA Pocket Guide to Nutrition Assessment.** 2nd ed. Chicago, IL: American Dietetic Association; 2004.
26. Malinowski SS. Nutritional and metabolic complications of bariatric surgery. **Am J Med Sci.** 2006;331(4):219-225.
27. Kaplan LM. Pharmacological therapies for obesity. **Gastroenterol Clin North Amer.** 2005;34(1):91-106.
28. Brolin RE, Gorman RC, Milgrim LM, Kenler HA. Multivitamin prophylaxis in prevention of post-gastric bypass vitamin and mineral deficiencies. **Int J Obes.** 1991;15(10):661-667.
29. Carmel R, Green R, Rosenblatt DS, Watkins D. Update on cobalamin, folate, and homocysteine. **Hematology Am Soc Hematol Educ Program.** 2003:62-81.
30. Rhode BM, Shustik C, Christou NV, MacLean LD. Iron absorption and therapy after gastric bypass. **Obes Surg.** 1999;9(1):17-21.
31. Brolin RE, Gorman JH, Gorman RC, et al. Prophylactic iron supplementation after Roux-en-Y gastric bypass: a prospective, double-blind, randomized study. **Arch Surg.** 1998;133(7):740-744.
32. Buffington CK, Walker B, Cowan GS Jr, Scruggs D. Vitamin D deficiency in the morbidly obese. **Obes Surg.** 1993;3(4):421-424.
33. Sakhaee K, Bhuket T, Adams-Huet B, Rao DS. Meta-analysis of calcium bioavailability: a comparison of calcium citrate with calcium carbonate. **Am J Ther.** 1999;6(6):313-321.
34. Dolan K, Hatzifotis M, Newbury L, Lowe N, Fielding G. A clinical and nutritional comparison of biliopancreatic diversion with and without duodenal switch. **Ann Surg.** 2004;240(1):51-56.
35. Kumar N, McEvoy KM, Ahlskog JE. Myelopathy due to copper deficiency following gastrointestinal surgery. **Arch Neurol.** 2003;60(12):1782-1785.
36. Kumar N, Ahlskog JE, Gross JB Jr. Acquired hypocuremia after gastric surgery. **Clin Gastroent Hepatol.** 2004;2(12):1074-1079.

37. Wu J, Ricker M, Muench J. Copper deficiency as cause of unexplained hematologic and neurologic deficits in patient with prior gastrointestinal surgery. *J Am Board Fam Med*. 2006;19(2):191-194.

Examination

1. Which procedure results in the lowest amount of stomach acid available for absorption?

- A. Adjustable gastric banding
- B. Vertical sleeve gastrectomy (gastric sleeve)
- C. Roux-en-Y gastric bypass
- D. Biliopancreatic diversion (BPD) with duodenal switch

2. A female patient presents with strong cravings for ice, new-onset heavy menstrual periods six months after gastric bypass surgery, and severe lethargy and shortness of breath. What nutritional deficiency does the patient probably have, and what would be the possible treatment?

- A. Iron-deficiency anemia; 50 to 100 mg/day of elemental oral iron, preferably chewable for better tolerance
- B. Thiamin deficiency; 20 to 30 mg/day of oral thiamin
- C. Folic acid deficiency; B-50 complex daily
- D. Magnesium deficiency; 400 mg/day of oral magnesium

3. A patient had gastric bypass surgery about four weeks ago and presents with severe nausea. He complains of dry heaving and notes that his primary care physician has ruled out any vitamin or mineral deficiencies. However, the patient was told he was dehydrated and needed to increase his water intake from 32 to 64 oz/day. What treatment will alleviate his nausea?

- A. Drinking warm water with meals to help digest his food
- B. Drinking cold water right before meals
- C. Sucking on frozen lemon or lime wedges
- D. Sucking on hard candy

4. Which of the following is not involved with the vertical sleeve gastrectomy procedure?

- A. Removal of approximately 80% of the stomach
- B. Removal of the fundus
- C. An initial 90% reduction of the hormone ghrelin
- D. A decrease in peptide YY and glucagonlike peptide-1 production

5. Mary had vertical sleeve gastrectomy surgery three months ago. She's now complaining of a frothy, white foam around her mouth when she eats, especially when consuming chicken or meat. She admits to eating too quickly, usually within 10 to 15 minutes, and then feeling overly full afterwards. Which of the following is most likely not a cause of the foam?

- A. Eating foods that are too dry
- B. Eating too quickly
- C. Sialorrhea
- D. Vomiting due to a surgical issue

6. Michael had Roux-en-Y gastric bypass surgery three years ago and hasn't been back to his surgical center since. He's been worried about a burning sensation in his feet for the past year that's gotten worse. In addition, he's also experiencing numbness in his feet and has been vomiting a few times per week after eating large meals. He hasn't taken his multivitamins or any other supplements since his surgery. What's most likely the cause of the burning and numbness in his feet?

- A. Thiamin deficiency
- B. Folic acid deficiency
- C. Iron deficiency
- D. Vitamin B₁₂ deficiency

7. Which of the following is not involved in Roux-en-Y gastric bypass surgery?

- A. Reduction in gastric capacity by 90% to 95%
- B. Bypass of the duodenum and the proximal jejunum as well as the majority of the stomach
- C. Malabsorption of macronutrients, including carbohydrates
- D. Anastomosis of the biliopancreatic limb above the ileocecal valve, which becomes the common limb

8. Jill began experiencing hair loss 12 months after undergoing bariatric surgery. To remedy the problem, she started taking hair and nail formula supplements. Which of the following is probably the cause of her hair loss?

- A. Thiamin deficiency
- B. Telogen effluvium
- C. Zinc deficiency
- D. Magnesium deficiency

9. James is a BPD duodenal switch patient who had surgery about one year ago but hasn't been taking his vitamin and mineral supplements for the past 10 months. He presents with memory loss, decreased night vision, a clumsy gait, and numbness and tingling in his fingers and hands. James is exhibiting possible signs and symptoms of all the following micronutrient deficiencies except:

- A. Vitamin B₁₂.
- B. Thiamin.
- C. Iron.
- D. Vitamin A.

10. You're about to review lab work results for a patient who underwent Roux-en-Y gastric bypass surgery to assess his risk of metabolic bone disease. Of the lab results below, which gives the best and earliest indication of suboptimal calcium levels?

- A. Low ionized calcium
- B. Elevated parathyroid hormone
- C. Low 1,25 dihydroxyvitamin D levels
- D. Low serum calcium