

Bariatric Surgery: Postoperative Management

Judy Shiaoⁱ, Laurent Bierthoⁱⁱ

- i) Division of Endocrinology and Metabolism, University of Ottawa
- ii) Department of Surgery, Laval University

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KEY MESSAGES FOR HEALTHCARE PROVIDERS

- Adherence to consistent post-operative behavioural changes (behaviour modification for nutrition plans, physical activity and vitamin intake) can optimize obesity management and health while minimizing post-operative complications.

- Working in partnership, the bariatric surgical centre, the local bariatric medicine specialist, the primary care provider and the patient living with obesity need to establish and commit to a shared care model of chronic disease management for long-term follow-up.
- The primary care provider should refer patients with post-bariatric surgery complications back to the bariatric surgical centre, or to a local bariatric medicine specialist.

RECOMMENDATIONS

1. Healthcare providers can encourage people who have undergone bariatric surgery to participate and maximize their access to behavioural interventions and allied health services at a bariatric surgical centre (Level 2a, Grade B).^{1,2}
2. We suggest that bariatric surgical centres communicate a comprehensive care plan to primary care providers on patients who are discharged, including: bariatric procedure, emergency contact numbers, annual blood tests required, long-term vitamin and mineral supplements, medications, behavioural interventions and when to refer back (Level 4, Grade D, consensus).
3. We suggest that after a patient has been discharged from the bariatric surgical centre, primary care providers should annually review: nutritional intake, activity, compliance with

multivitamin and mineral supplements, and weight, as well as assess comorbidities, order laboratory tests to assess for nutritional deficiencies and investigate abnormal results and treat as required (Level 4, Grade D, consensus).

4. We suggest that primary care providers consider referral back to the bariatric surgical centre or to a local specialist for technical or gastrointestinal symptoms, nutritional issues, pregnancy, psychological support, weight regain or other medical issues as described in this chapter related to bariatric surgery (Level 4, Grade D, consensus).
5. We suggest that bariatric surgical centres provide follow-up and appropriate laboratory tests at regular intervals post-surgery with access to appropriate healthcare professionals (dietitian, nurse, social worker, surgeon, bariatric physician, psychologist/psychiatrist) until discharge is deemed appropriate for the patient (Level 4, Grade D, consensus).

KEY MESSAGES FOR PATIENTS LIVING WITH OBESITY WHO HAVE HAD BARIATRIC SURGERY

1. If you have had bariatric surgery, it is important for you to take your nutritional supplements lifelong and to continue to follow the post-bariatric surgical nutrition plan, exercise and any other recommendations given by your original specialist team. By doing this, you will increase your chances of staying healthy and reduce complications that can arise from bariatric surgery.
2. Attend all scheduled appointments and programming offered by your bariatric surgical site. Once you are discharged from the bariatric surgical site, schedule annual appointments with your primary care provider to check your bloodwork, reassess your medications and address any issues related to changes in your weight.
3. After bariatric surgery, it is possible that there can be a negative impact on mood, relationships, body image, development of addictions and reduced ability to cope with stress. If you are struggling, discuss this with your original specialist team or, if you have been discharged, with your primary care provider.
4. Remember that your lowest weight post-surgery will occur between 12 to 18 months. After this, there is a natural increase in weight that occurs. If you are gaining excessive amounts of weight, discuss this with your bariatric team or primary care provider.
5. If you are 12 to 18 months post-bariatric surgery and are planning a pregnancy, discuss this with your bariatric team, primary care provider and obstetrician.

Post-bariatric surgery health behaviour changes

Post-bariatric surgery diet

Centres that perform bariatric surgery will typically provide patients with a dietary protocol to follow. Initially, over several weeks, patients transition from liquid, to soft and then to a solid diet. Over the long term, patients are encouraged to follow a structured post-bariatric surgical diet involving small portions, three to five balanced and structured meals and healthy snacks (chew foods slowly and avoid sweets). For beverages, patients should not eat and drink at the same time (avoid liquids within 30 minutes of eating solids). Carbonated beverages and caffeinated drinks are to be avoided, as the phosphoric acid and caffeine, respectively, can increase the risk of ulcerations.

After bariatric surgery, patients need to follow a low-fat, moderate carbohydrate and high-protein diet. Post-operative protein recommendations range from 1.2 to 1.5 g/kg/day based on goal body weight (minimum of 60 g protein/day for laparoscopic sleeve gastrectomy/Roux-en-Y gastric bypass, and 80–120 g/day for duodenal switch). Consulting a registered dietitian can support changes in eating behaviours and guide patients on their nutrition needs.³ There is no advantage to prescribing alternate diets (e.g. low carbohydrate, high protein), probiotics or amino acids.⁴⁻⁶

Other behavioural changes to consider

Alcohol intake should be minimal or avoided due to changes in pharmacokinetics. For example, in women who are post Roux-en-Y gastric bypass, two alcoholic beverages are equivalent in absorption to four alcoholic beverages.⁷ Seven percent of patients report new high-risk alcohol use one year after bariatric surgery, though, on a more positive note, half who reported high-risk alcohol use before surgery discontinued high-risk drinking.⁷

Activity: Long term, a standard of 150 to 300 minutes of activity/week is recommended for post-bariatric surgical patients. Post-operative higher-volume exercise can help promote further weight loss⁸⁻¹⁰ but sustaining this level activity is difficult.¹¹

Smoking cessation: Abstention from cigarettes is recommended. Cigarette smoking can increase risk of peptic ulcer disease, particularly marginal ulcers.

Marijuana: There is a paucity of studies on the use of marijuana post bariatric surgery. One concern would be the impact of weight loss and the chronic use of marijuana, which is traditionally known for its “munchies” effect. At this point, moderation, if not abstention, would be a safe recommendation.

Post-bariatric surgery vitamin supplementation

The evidence for the role of vitamin supplementation (amount, duration) varies depending on which vitamin, mineral or type of bariatric procedure are studied. Generally, some type of vitamin supplementation is needed for all bariatric surgical procedures, with tailoring for those that have a hypoabsorptive component (Roux-en-Y gastric bypass, duodenal switch).

Practically, it makes sense that a standardized minimum prescription of vitamins be set for all bariatric surgeries. It is a natural human tendency to eventually forget taking supplements. Setting a standard means that clinicians can be consistent in their messaging about taking vitamins. Deficiencies of vitamins and some minerals can leave serious and potentially nonreversible side effects. Frequency of laboratory monitoring may vary depending on the individual and type of procedure, but at minimum an annual check should be conducted to ensure that patients are not becoming malnourished. Tables 1 and 2 summarize the recommen-

dations for vitamin supplementation, associated deficits that can occur with various deficiencies, and frequency of monitoring. Table 3 summarizes clinical features that may point toward a nutrient deficiency. A dietitian can help determine what combination of vitamins makes sense for a patient. In Canada, access to all-in-one bariatric supplements for surgical patients is improving and can help compliance by reducing the number of pills that need to be taken. Gummy vitamins should be avoided as they do not contain essential minerals.

Post-bariatric surgery complications

Many gastrointestinal (dumping syndrome) and metabolic complications (e.g. bone, kidney stones) can be prevented by following the recommended post-bariatric surgery nutrition plan and vitamin intake.

Dumping syndrome

Dumping syndrome is divided into early and late phases. Early dumping syndrome occurs within the first hour after a meal. Because of the hyperosmolality of the food, rapid fluid shifts occur from the plasma compartment into the intestinal lumen, resulting in hypotension and a sympathetic nervous system response. Early dumping is characterized by gastrointestinal symptoms such as abdominal pain, bloating, borborygmi, nausea and diarrhea, and vasomotor symptoms, such as fatigue, desire to lie down after meals (a classic symptom), flushing, palpitations, perspiration, tachycardia, hypotension, and, rarely, syncope. In contrast, late dumping usually occurs one to three hours after a meal and is a result of an incretin-driven hyperinsulinemic response after carbohydrate ingestion. Hypoglycemia-related symptoms are related to neuroglycopenia (fatigue, weakness, confusion, hunger and syncope) and autonomic/adrenergic reactivity (perspiration, palpitations, tremor and irritability).¹²

Symptoms that persist despite returning to a post-bariatric surgery diet may benefit from a trial of either acarbose, a calcium channel blocker, diazoxide or octreotide. Referral to a bariatric medicine specialist or an endocrinologist for management and to rule out other causes of hypoglycemia (nesidioblastosis, insulinoma, factitious) may be warranted.¹³

Abdominal discomfort

Abdominal discomfort has a long differential from dietary indiscretion (overeating), dumping syndrome, biliary colic, stenosis of the gastro-jejunostomy, marginal ulcer or small bowel obstruction. Presentation for small bowel obstruction can come at any time, but can be divided into early (< 30 days; secondary to adhesions or incarcerated hernias) or late (>1 year; internal hernia, which can be seen post Roux-en-Y gastric bypass or duodenal switch). During the first year, there is a need for a higher level of suspicion for pain secondary to a surgical complication. Tachycardia, unstable vital signs and abdominal pain may be suggestive of a surgical leak, internal hernia or cholecystitis, which warrants immediate

surgical referral. With diarrhea, constipation or bloating, referral to a dietitian can help identify healthier food choices and proper fibre content. Probiotics may improve symptomatic gastrointestinal episodes.

There should be a high level of suspicion for an ulceration for patients who use non-steroidal anti-inflammatory drugs (NSAIDs). Referral to the bariatric surgical site should be considered when clinical red flags appear such as unexplained, frequent, moderate-to-severe abdominal pain, daily intolerance to most solid foods, daily nausea and vomiting, and/or a significant amount of weight regain (>25%–50% of total weight loss) in a short space of time. Every bariatric patient suffering from persistent vomiting severe enough to interfere with regular nutrition should be promptly started on oral or parenteral thiamine supplementation, even in the absence or before confirmatory laboratory data.¹⁴

Bone health

Post-bariatric surgery, bone demineralization 15–17 and fracture risk,¹⁸ particularly after duodenal switch, are increased. A major cause of bone loss is impaired intestinal calcium absorption, which leads to stimulation of parathyroid hormone (secondary hyperparathyroidism) and bone resorption.¹⁷ The evidence for monitoring, prevention and treatment is not well described. At minimum, adequate protein intake in combination with routine physical activity in addition to the routine supplementation of calcium citrate and vitamin D are recommended.^{17,19} It is recommended to adjust calcium and vitamin D intake to achieve normal serum calcium, vitamin D and parathyroid hormone levels. Calcium citrate is preferred over calcium carbonate as it is better absorbed in the absence of gastric acid. Elevated parathyroid hormone in the setting of inappropriately high serum calcium and normal vitamin D levels is suggestive of primary hyperparathyroidism and requires further investigation.

The role of bone mineral density testing prior to bariatric surgery is controversial,²⁰ particularly due to technical difficulties when patients are at a higher body mass index (BMI). We suggest ordering bone mineral density testing on a patient at two years post-surgery, when weight is at its nadir. Subsequent bone mineral density testing can be ordered based on clinical need.²⁰ If a patient does have osteoporosis, then intravenous bisphosphonates (zoledronate 5 mg once a year, ibandronate 3 mg every three months) are the preferred choice, as there is a risk of anastomotic ulcer with oral bisphosphonates. Prior to starting bisphosphonate therapy, it is important that vitamin D levels be fully replete to prevent the development of hypocalcemia, hypophosphatemia and osteomalacia.²¹

Nephrolithiasis

Patients who have had bariatric surgery are at higher risk of new onset nephrolithiasis, with the mean interval from surgery to diagnosis of nephrolithiasis ranging from 1.5 to 3.6 years. The risk of nephrolithiasis, typically calcium oxalate stones, varies by procedure, being the highest for hypoabsorptive procedures (22% to 28.7%), intermediate for Roux-en-Y gastric bypass (7.65% to

13%) and the lowest for purely restrictive procedures (laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy) where it approaches that of non-operative controls.²² Unabsorbed fat in the intestine binds with calcium, which typically would bind oxalate. Oxalate is reabsorbed from the intestine and is subsequently filtered by the kidney, resulting in hyperoxaluria. With concomitant hypocitraturia (from intestinal alkali loss), there is a higher propensity for calcium oxalate stone formation. Basic therapeutic strategies to manage hyperoxaluria include calcium citrate supplementation, increased hydration, limiting dietary oxalate and adhering to a low-fat diet.^{17,23} Commonly, individuals often believe that kidney stones are caused by taking too much calcium, and that calcium supplementation should be discontinued. The exact opposite is true, in that they should remain on their calcium citrate supplementation, which not only helps bind intestinal oxalate but also provides citrate for the urine. There is some evidence to suggest that pyridoxine (B6) deficiency plays a role in kidney stone formation, highlighting the importance of taking vitamin supplementation consistently.²⁴ Certain probiotics (containing either *Lactobacillus* alone or in combination with *Streptococcus thermophilus* and *Bifidobacterium*) may play a complimentary role in reducing gastrointestinal oxalate absorption if basic strategies are insufficient.^{25,26}

Psychological complications and treatments post op

Though bariatric surgery is one of the most effective treatment options for obesity, clinicians should be aware of the potential post-bariatric psychological issues that may arise, including depression, suicide,^{27,28} body image disorder, eating disorders,²⁹ and substance and alcohol abuse.⁷ Results from bariatric surgery may not meet a patient's expectations or may not lead toward hoped improvements in quality of life, thus impacting mood.¹⁴ Beyond providing knowledge on diet and exercise, clinicians should address improvement in patient's self-esteem and self-motivation. Patients who have had post-bariatric comprehensive behavioural-motivational nutrition education have decreased risk for depression and improved weight loss outcomes.^{1,30,31} Primary care providers may need to refer the post-bariatric surgical patient for more in-depth psychological counselling, such as cognitive or dialectical behaviour therapy. Refer to [The Role of Mental Health in Obesity Medicine](#) and [Effective Psychological and Behavioural Interventions for People Living with Obesity](#) chapters for more details.

Weight regain

Nadir weight (lowest weight point) occurs one to two years post-bariatric surgery. Weight loss stops partly because of adaptive changes in the intestine, changed patient habits, and metabolic adaptation.³² After this, it is normal to expect some weight regain. However, there is no consistent absolute number in the literature that defines pathological weight regain post bariatric surgery. Studies that have been conducted in the bariatric surgery population show that significant weight regain ($\geq 15\%$ gain of initial weight loss post bariatric surgery) occurs in 25%–35% of people who undergo surgery two to five years after their initial surgical date.³³ The Swedish Obese Subjects study, the largest non-ran-

domized intervention trial comparing weight loss outcomes in a group of over 4000 surgical and nonsurgical individuals, reported that, at 10 years, individuals who underwent Roux-en-Y gastric bypass had a mean weight regain of 12% of total body weight, which translates into regaining 34% of the maximal lost weight achieved at one year.^{29,34} The consensus for some Canadian bariatric surgical sites is that weight regain is defined as $>25\%$ regain of total weight lost. The underlying factors that influence weight regain following bariatric surgery are multifactorial, and include endocrine/metabolic alterations, anatomic surgical failure, nutritional indiscretion, mental health issues and physical inactivity.²⁹

Even prior to surgery, emphasizing realistic weight trajectories and expectations may theoretically help reduce the anxiety that some patients go through as they mentally try to transition from losing weight to healthy living and maintaining weight loss. Patients who experience weight regain may perceive that the surgery has failed, or they may enter a cycle of helplessness by blaming themselves and feeling shamed. It is important that clinicians mitigate these feelings by explaining that some weight regain following bariatric surgery is normal, and then proceeding in a stepwise approach to address the weight regain. It is neither necessary nor economical to order an esophagogastroduodenoscopy or an upper gastrointestinal contrast study to evaluate the gastrointestinal tract on every patient who is experiencing weight regain following surgery. The following steps are suggested to address weight regain:

- Ensure that the patient continues to follow the recommended post-bariatric surgery nutrition plan and vitamin intake. Check bloodwork to ensure that vitamin and mineral levels are in the normal range. If a person is malnourished at baseline, then more harm occurs trying to help the person lose further weight. Referral to a dietitian can be helpful at this stage.
- Psychological intervention may be required to address mood, anxiety, an eating disorder, or to help a patient make behaviour changes.
- If on subsequent follow ups, despite adherence to post-bariatric surgery nutrition plan and vitamin intake, weight does not decrease, then an esophagogastroduodenoscopy or upper gastrointestinal contrast study may rule out an anatomical failure. Detection of an anatomical failure would lead to a referral back the bariatric surgical team.
- Consideration of medications for obesity management post-bariatric surgery may be made for patients who are trying to follow the post-bariatric surgery nutrition plan and taking their vitamin supplementation. Orlistat should not be used in patients who have had hypoabsorptive procedures. Retrospective reports have demonstrated that liraglutide^{35,36} or bupropion/naltrexone³⁷ may play a role in reducing weight regain.

After all the above steps, if weight regain still remains an issue, then consider referring back to a bariatric surgery centre for eligibility of surgical revision.

Medications

Following bariatric surgery and the resulting weight loss, many studies demonstrate a reduction of medications for diabetes, dyslipidemia, cardiovascular and antihypertensive agents. There are a limited number of publications that focus on the pharmacodynamics of medications post-operatively (Table 4). Ultimately, there remains a large interindividual variation and the therapeutic effects of a medication must be individually dose adjusted.

For the first three to eight weeks post-surgery, medications should be consumed in a crushed or liquid form or by opening capsule contents. It is important that the liquid form does not contain absorbable sugars to avoid dumping syndrome.³⁸ Some medications, however, should not be crushed.³⁹ Post Roux-en-Y gastric bypass and duodenal switch, the pharmacokinetic profile of many medicines may be altered due to changed intestinal absorption surface, lipophilicity of drugs, increased pH in the stomach, reduced cytochrome P450 (CYP) enzyme activity and first-pass intestinal metabolism, time after bariatric surgery, and changes in volume of distribution.⁴⁰ Immediate-release formulations are generally preferred over extended release. Nonsteroidal anti-inflammatory drugs should be avoided after Roux-en-Y gastric bypass or duodenal switch due to risk of anastomotic ulceration/perforations. For other bariatric procedures, non-steroidal anti-inflammatories (NSAIDs) use should be accompanied with proton pump inhibitors (PPIs) for mucosal protection.⁴¹ Patients who need to remain on low dose aspirin for secondary prevention may do so but should have additional PPI protection. Especially for Roux-en-Y gastric bypass and duodenal switch procedures, patients taking long-term warfarin require a postoperative dose reduction of >20% with closely monitored international normalized ratio (INR). Direct oral anticoagulants (DOACs) should be avoided due to the potential for decreased drug absorption. If a betablocker after bariatric surgery is needed, a hydrophilic compound like atenolol may be preferred. Bioavailability of oral contraceptives may be reduced post-bariatric surgery, and alternate methods of contraception need to be considered. Antidiabetic medications with a risk for hypoglycemia (such as sulfonylureas) should be discontinued and insulin doses adjusted. Metformin may be continued but the dose may need to be reduced due to increased absorption.⁴² Primary care providers may benefit from working with a patient's community pharmacist for medication adjustments.

Special considerations for bariatric surgery on fertility

Bariatric surgery should not be considered a treatment for infertility.⁵⁴ Many studies related to fertility in women post-bariatric surgery are small, and appropriate control groups have not always been included. Together, the evidence suggests that bariatric surgery improves fertility, whether it is through improvements of sex hormonal profiles or resolution of polycystic ovary syndrome markers which influence fertility (including anovulation, hirsutism, hormonal changes, insulin resistance, sexual activity and libido).⁵⁵ The type of surgery does not appear to be related to changes

in fertility, as only the amount of weight lost (a BMI decrease of greater than 5 kg/m²) and the BMI achieved at time of conception were predictive of becoming pregnant.⁵⁶

In men, surgery-induced massive weight loss does not impact sperm quality, but it does increase the quality of sexual function, total testosterone, free testosterone and FSH, and reduces prolactin.⁵⁷ Overall, in men, the balance between positive (hormonal, psychological and sexual improvements) and negative (nutritional depletion due to selective food maldigestion and malabsorption) impacts will determine the final effect on seminal quality and fertility.⁵⁷

Women who became pregnant before one year after bariatric surgery presented with a higher rate of fetal loss in comparison to women whose pregnancy occurred after this period of time (35.5 versus 16.3 %). Pregnancy is therefore not recommended in the first 12–18 months following bariatric surgery,⁵⁸ by which time weight is more stable and women are able to consume a nutritionally balanced diet. Thus, adequate contraception should be offered to women of reproductive age who undergo bariatric surgery. As estrogen is absorbed in the upper gastrointestinal tract which is modified during bariatric surgery, oral contraception pills should be avoided for Roux-en-Y gastric bypass and biliopancreatic diversion/duodenal switch. Instead, normal forms of hormonal contraception (etonogestrel implant⁵⁹ or a levonorgestrel releasing intrauterine device⁶⁰) may be considered. There is no definitive contraindication to oral contraception pills for gastric banding and sleeve gastrectomy.^{14,61}

Special considerations in women who have had bariatric surgery and pregnancy

Compared with women who have obesity and who have not undergone bariatric surgery, women who became pregnant after bariatric surgery had a lower risk of gestational diabetes, hypertensive disorders, and macrosomia. However, risk of small-for-gestational-age newborns increases after bariatric surgery.⁶²

Preconception care

Women planning conception post-bariatric surgery should have daily oral supplementation with a multivitamin containing 1.0 mg folic acid, beginning at least three months before conception. Women should continue this regime until 12 weeks gestational age. From 12 weeks gestational age, continuing through the pregnancy, and for four to six weeks postpartum or as long as breast feeding continues, continued daily supplementation should consist of a multivitamin with 0.8 mg to 1.0 mg folic acid.⁶³ B12 levels should be checked and corrected if deficient prior to initiation of additional folic acid. Women are advised to avoid vitamin and mineral preparations which contain vitamin A in the retinol form in the first 12 weeks of pregnancy, as supplements containing retinol may increase the teratogenic risk (especially in the first trimester). It is therefore recommended that pregnant women and those planning pregnancies following bariatric surgery are supplemented with vitamin A in the beta-carotene form.

Nutritional monitoring during pregnancy

Standard complete multivitamins routinely used post-bariatric surgery should be substituted for prenatal multivitamins to reduce vitamin A intake, which should not exceed 5000 IU/day. Continue all other regular supplementation that the patient typically would be on, and then adjust according to laboratory testing. Laboratory testing at each trimester should include CBC, ferritin, albumin, B12, 25-Hydroxy (OH) vitamin D, calcium, parathyroid hormone and folate. Patients who have had hypoabsorptive surgery should additionally have zinc, copper and vitamin A levels (and possibly vitamin E and K levels with duodenal switch) monitored during pregnancy.^{14,55,64,65}

If the patient is vitamin A deficient, then supplementation should be in the form of beta-carotene vitamin A.⁶⁴ Patients suffering from nausea and intractable vomiting should have immediate B1 supplementation and careful monitoring of B1 levels. Nutrition advice from an experienced registered dietitian should be offered to review deficiencies, vitamin supplementation and ensure a recommended daily protein intake of 60 g.⁵⁴ Possible recommended gestational weight gain would be based on pre-pregnancy BMI as per the Institute of Medicine.⁶⁶

Other considerations during pregnancy

In addition to nutritional deficiencies, there is also the potential for severe, life-threatening complications, such as internal hernias, bowel obstructions, volvulus, intussusception and gastric perforations,

which generally occur one to three years after bariatric surgery. Because of the upward pressure from the gravid uterus, these late sequelae may present in pregnancy and during the immediate postpartum period. Abdominal pain in a post-bariatric surgical gravid woman would need to include these potential complications in the differential diagnoses. Radiologic evaluation with computed tomography scan should be reviewed by bariatric surgeons or radiologists with specialized expertise in this area.⁶⁷ Post-surgical patients may not tolerate the 50 g glucose solution commonly administered at 24–28 weeks of gestation to screen for gestational diabetes. Alternative measures to screen for gestational diabetes should be considered for patients who have undergone hypoabsorptive-type surgery. One proposed alternative is home glucose monitoring (fasting and two-hour postprandial blood sugar) for approximately one week during the 24–28 weeks of gestation.⁵⁴

Postpartum

Breast feeding should be encouraged. It is important that postpartum bariatric surgical patients continue their recommended vitamin supplementation, as there have been documented cases of nutritional deficiencies in breast fed infants born to mothers who have had Roux-en-Y gastric bypass.⁶⁸

Table 1: Post-Bariatric Surgery Nutrition and Exercise, Vitamin Supplementation and Monitoring for Prevention of Complications

Post-bariatric surgery nutrition and exercise: Eat 3–5 small meals; chew food slowly; aim for minimum 60g protein/day (LS/RYGB) or 80g–120 g protein/day (duodenal switch/DS); separate liquids and solids by 30 minutes; no carbonated or caffeinated beverages; minimal to no alcohol intake; no smoking, no NSAIDs or DOACS post RYGB and DS; activity: 150 to 300 minutes/week.

Vitamins and minerals	Daily prevention recommendation post-bariatric surgery (solid line means difference in dosing; — means no evidence of difference in dosing between the types of bariatric surgery)			Description of supplement with suggested timing (most patients will require complete multivitamins [MVs] with additional supplementation of B12, D, calcium and iron)
	Laparoscopic Adjustable Gastric Banding or Sleeve	Roux-en-Y Gastric Bypass	Duodenal Switch	
Vitamin B2 (Riboflavin)		3.4 mg		<p>Take complete MVs at breakfast.</p> <p>The vitamins and minerals listed on the left can be found in OTC complete MVs. Patients and clinicians need to carefully check labels as formulations differ between brands and sometimes can change.</p> <p>Generally, patients will need two complete OTC MV / day to reach the daily recommendations post bariatric surgery.</p> <p>The ratio of zinc:copper should remain 8–15 mg:1 mg.</p> <p>Some marketed vitamins are labelled as post bariatric surgery vitamins but may still need additional calcium, iron, B12 or vitamin D supplementation. Read labels carefully and adjust according to lab results.</p> <p>If pregnant, switch OTC MV to prenatal vitamin, not to exceed 5000 IU of vitamin A per day. Avoid retinol-based vitamin A during pregnancy and lactation; it is safe to continue beta-carotene. Additional screening and increased requirements of vitamin A in duodenal switch or if steatorrhea presents.</p>
Vitamin B3 (Niacin)		40 mg		
Pantothenic acid (B5)		20 mg		
Vitamin B6		4 mg		
Biotin		60 mcg		
Vitamin C		120 mg		
Selenium		140 mcg		
Magnesium		400 mg		
Manganese		4 mg		
Chromium		120 mcg		
Molybdenum		50 mcg		
Zinc	8–11 mg	8–22 mg	16–22 mg	
Copper	1 mg	1–2 mg	2 mg	
Vitamin A	5000–10000 IU	5000–10000 IU	10000 IU	
Vitamin K	90–120 mcg	90–120 mcg	300 mcg	
Vitamin E		15mg		
Folic acid		400–800 mcg		
Folic acid (pre-conception to 12 weeks GA)		1000 mcg		
Folic acid from >12 wks to breastfeeding/ or 4–6 wks postpartum		800–1000 mcg Duodenal Switch		

ADDITIONAL SUPPLEMENTS				
Vitamins and minerals	LAGB or LS	RYGB	DS	Description of supplement with suggested timing
Vitamin B1 (thiamine)		12 mg		If insufficient amount in complete MV, add a 50 mg B-complex supplement Take at breakfast
Vitamin B1 for at-risk patients*		50–100 mg		Take two 50 mg B-complex supplements
Vitamin B12		350–500 ug		Take at breakfast Oral: 350–500 ug/day Nasal spray: as directed by manufacturer Parenteral (IM or SC): 1000 ug monthly
Vitamin D		3000 IU		Take at breakfast Titrate vitamin D supplementation: To maintain 25(OH)D levels at > 75nmol/L To parathyroid hormone levels It is not uncommon that for duodenal switch, higher supplementation of vitamin D (as high as 50,000 IU 2-3 times/week) may be required. D3 (cholecalciferol) is preferred over D2 (ergocalciferol) for its more potent effect
Calcium (from food and supplements)	1200–1500 mg	1200–1500 mg	1800–2400 mg	Take in divided doses Calcium citrate (preferred) with or without meals Calcium carbonate with meals Titrate to calcium and parathyroid hormone levels
Iron	18 mg			Take before bed Do not take with calcium as absorption blocked.
Low risk (men and patients without history of anemia)				
Menstruating women	45–60 mg			Ferrous sulphate is the preferred iron supplement, but others may be considered if this supplement is not tolerated Take with vitamin C 250–500 mg for better absorption with non-heme iron supplements Formulations of different non-heme iron supplements (elemental iron mg): <ul style="list-style-type: none"> • Ferrous sulphate 300 mg (60 mg) • Ferrous gluconate 300 mg (35 mg) • Ferrous fumarate 300 mg (99 mg) There is no evidence for the role of heme iron supplements (11 mg elemental heme iron/tablet) for prevention of anemia in post bariatric surgical patients. However, if this is what is tolerated clinically, careful monitoring of CBC and ferritin levels are warranted

*At-risk factors include GI symptoms such as intractable nausea and vomiting, malnutrition, excessive and/or rapid weight loss, excessive alcohol use

LAB MONITORING				
	LAGB or LS	RYGB	DS	Comments
Lab values to monitor	CBC, electrolytes, albumin, ferritin, B12, folate, calcium, 25(OH) vitamin D, PTH	Same as LAGB/LS + vitamin A, zinc, copper	Same as RYGB + INR	Screen for thiamine for at-risk patients* or who have clinical features related to thiamine deficiency (see Table 2)
Lab frequency	Every 3–6 months	Every 3-6 months	Every 3 months	In pregnancy, labs should be monitored each trimester: CBC, ferritin, albumin, B12, 25(OH) D, calcium, PTH, folate
First year post-op:	Yearly	Yearly	Every 6-12 months	For hypoabsorptive surgeries add zinc, copper, vitamin A (for duodenal switch possibly add vitamin E and vitamin K)
Thereafter:				Vitamin A levels with RYGB and DS need to be adjusted

*At risk factors include GI symptoms such as intractable nausea and vomiting, malnutrition, excessive and/or rapid weight loss, excessive alcohol use
LAGB: laparoscopic adjustable gastric banding; LS: laparoscopic sleeve; RYGB: Roux-en-Y gastric bypass; DS: duodenal switch; NSAIDs: non-steroidal anti-inflammatory drugs; DOACs: direct oral anticoagulants; OTC: over-the-counter; MV: multivitamin; CBC: complete blood count

Source: Shiao, J.

Table 2: Treatment for Post-Operative Deficiencies and Suggested Supplementation^{43–47}

Micronutrient	Post-op deficiency prevalence	Food Sources	Signs/symptoms of deficiency	Treatment for deficiency
Vitamin B3 (niacin)		Yeast, liver, cereals, legumes, seeds	4D's of Pellegra: Dermatitis: photosensitive, pigmented Diarrhea Dementia Death	
Magnesium	32%		Muscle contractions, pain, spasms, osteoporosis	Oral magnesium
Zinc	LS: 12% RYGB: 21–33% DS: 74–91%	Meat, chicken, nuts, lentils, breakfast cereals are fortified	Skin lesions, poor wound healing, dermatitis, blunting of taste sense, hair loss, altered immune function, alopecia, glossitis, infertility	Remember: Zinc:copper: 8–15 mg:1 mg as zinc supplementation can cause a deficiency in copper (e.g.: if taking zinc 50 mg/d, then add copper 4 mg/d)
Copper	RYGB: 2% DS: 10–24%	Everything (vegetables, grains, meat, fish, poultry)	Anemia, leukopenia, hypopigmentation of hair, skin, nails, unsteady gait, numbness and tingling in hands and feet, painful paresthesia, poor wound healing, peripheral neuropathy, myelopathy, paralysis	If copper deficient: Mild-moderate deficiency (including low hematologic indices): 3–8 mg/d copper gluconate or sulfate Severe deficiency: 2–4 mg/d iv copper for 6 days or until serum levels return to normal and neurologic symptoms resolve. Toxicity level: Zinc 24-h urine >1200 ug/d Copper women >155 ug/dL Copper men >140 ug/dL

Micronutrient	Post-op deficiency prevalence	Food Sources	Signs/symptoms of deficiency	Treatment for deficiency
Vitamin A	RYGB: 8–11% DS: 61–69%	Preformed vitamin A (retinol): liver, kidney, egg yolk, butter Provitamin A (beta-carotene): leafy greens, carrots, sweet potatoes	Loss of nocturnal vision, Bitot's spots (foamy white spots on sclera), itching, dry hair, xerophthalmia, decreased immunity, poor wound healing, hyperkeratinization of the skin, loss of taste (Vit A and zinc metabolism interrelated).	No corneal changes: 10000–25000 IU/day orally for 1–2 weeks Corneal lesions present: 50000–100000 IU/day <i>im</i> for 3 days followed by 50000IU/day <i>im</i> for 2 weeks Toxicity level: >80 ug/dL
Vitamin E		Olive oil, meat, eggs, leafy vegetables	Gait ataxia, hyporeflexia/weakness, nystagmus, ophthalmoplegia, ceroid deposition in muscle	
Vitamin K			Skin hemorrhages (petechia, purpura, ecchymosis)	For post bariatric surgery patients with hypoabsorption, the recommended dosage of vitamin K is either 1–2 mg/d orally or 1–2 mg/wk parenterally
Folic acid	9–38%	Animal products, leafy vegetables; easily destroyed by heat of cooking	Macrocytic anemia, palpitations, fatigue, neural tube defects, changes in pigmentation or ulceration of skin, nails, or oral mucosa	1 mg/day orally for 1–3 months
Vitamin B1 (thiamine)	Up to 49%	Yeast, legumes, pork, rice, cereals; denatured at high temperature	Dry beriberi: symmetrical peripheral neuropathy; convulsions, muscle weakness +/- pain of lower and upper extremities, brisk tendon reflexes Wet beriberi: heart failure, tachycardia or bradycardia, lactic acidosis, dyspnea, leg edema, RV dilatation Wernicke's encephalopathy: polyneuropathy and ataxia, ocular changes (ophthalmoplegia and nystagmus), confabulation, short-term memory loss Korsakoff psychosis: psychosis and /or hallucinations	Treat for suspected thiamine deficiency before or in the absence of lab confirmation. Oral: 100 mg bid-tid until symptoms resolve IV: 200 mg tid or 500 mg od-bid for 3–5 days, followed by 250 mg/d for 3–5 d or until symptoms resolve. <i>im</i> : 250 mg od for 3–5 days or 100–250 mg monthly Simultaneous administration of magnesium, potassium and phosphorus should be given to patients at risk for refeeding syndrome.
Vitamin B12	2 years post RYGB/DS: 4 to 62%; 5 years post RYGB/DS 19–35%	Meat and dairy products	Pernicious anemia, tingling in fingers and toes, depression, dementia, ataxia, sore tongue, smooth and "beefy red" tongue, pale skin, slightly icteric skin and eyes.	1000 or 2000 ug/day (1–2 ampoules) orally or 1000 ug/week <i>im</i>

Micronutrient	Post-op deficiency prevalence	Food Sources	Signs/symptoms of deficiency	Treatment for deficiency
Vitamin D	25–80%		Osteomalacia, arthralgia, depression, fasciculation, myalgia	Vit D3 is more potent than Vit D2 when comparing frequency and amount needed for repletion. Vitamin D3 3000 to 6000 IU/d or Vitamin D2 50,000 IU 1–3 times weekly. Toxicity level: >150 ng/mL
Calcium (from food and supplements)	Approx. 10%	E.g.: food=mg calcium 1 cup milk=300 mg 1 oz cheese=250 mg ¾ cup yogurt=200 mg ½ cup cooked leafy greens=50 mg	Low bone density, osteoporosis, muscle contractions, bone pain, spasms, paresthesia, muscle weakness, tetany	Adjust calcium and vitamin D intake based on normalizing lab values of calcium, 25(OH) vitamin D and PTH levels
Iron	LS: 17% RYGB/DS: 30% (45% after 2 years)		Fatigue, impaired work performance and productivity, microcytic anemia, decreased immune function, enteropathy, glossitis, dysphagia, spoon-shaped nails (koilonychias), vertical ridge on nails	Can increase oral non-heme iron intake in divided doses to provide 150–200 mg elemental iron daily (e.g.: ferrous sulfate 300 mg tid) ⁴⁸ Take separately from calcium supplements, acid-reducing medications – if no response, then consider parenteral iron administration Heme iron for treatment of post Roux-en-Y gastric bypass iron deficiency is not recommended as first line but may be considered if patient does not tolerate non-heme iron; The dosing would be 4 tablets of heme iron daily.

Source: Shiao, J.

Table 3: Clinical Features that Patients Might Present Post-Bariatric Surgery with Possible Related Nutrient Deficiency^{43,47}

Clinical features	Possible micronutrient deficiency
Hair	
Alopecia	Iron, zinc, biotin, protein deficiency
Corkscrew hair	Vitamin C
Eyes	
Night blindness, ocular xerosis, keratomalacia, Bitot's spots	Vitamin A
Ophthalmoplegia	Thiamine, vitamin E
Optic neuropathy	B12, thiamine (Wernicke), copper (rarely folate)
Face/skin	
Dermatitis: hyperpigmentation around sun-exposed skin: face, neck and hands	Niacin
impaired wound healing	Zinc, Vit C, protein deficiency,
Petechia, purpura	Vit C, Vit K
Mouth	
Soreness, burning	Riboflavin (B2)
Angular stomatitis or cheilitis	B2, niacin, iron, B6, B12; or vitamin A toxicity
Pica	Iron, zinc
Hypogeusia or dysgeusia	Zinc
Glossitis (sore, swollen, red and smooth tongue)	Folate, riboflavin, niacin, B6, B2, folate, severe iron deficiency
Gingival bleeding	Vitamin C, niacin, folate, zinc, severe vitamin D deficiency; or vitamin A toxicity
Beefy red tongue	Folate, niacin, B12
Nails	
Beau's lines (transverse ridges, horizontal grooves)	Zinc, protein, calcium
Koilonychia	Iron, protein, anemia
Splinter hemorrhage	Vitamin C
Brittle, soft, dry, weak, thin; split easy	Magnesium; or vitamin A toxicity and selenium toxicity
Musculoskeletal	
Bone pain	Vitamin D
Calf tenderness, absent deep tendon reflexes, foot and wrist drop	Thiamine
Peripheral neuropathy, tingling, "pins and needles"	Folate, B6, pantothenic acid, phosphate, thiamine, B12
Muscle twitching, convulsions, tetany	Calcium, vitamin D, Mg deficiency, B6 (or excess Mg and B6)
Muscle cramps	Chloride, sodium, potassium, magnesium, calcium, vitamin, dehydration
Muscle pain	Vitamin D, biotin
Sexual	
Hypogonadism, erectile dysfunction	Zinc
Hematology	
Anemia and fatigue	Protein, zinc, copper, selenium
Microcytic anemia	Iron, copper, pyridoxine, vitamin E
Macrocytic anemia	B12, folate
Neutropenia	Copper
Nervous System	
Ataxia	B12, copper
Myelopathy	B2, copper (rarely folate, vitamin E)
Polyradiculopathy	Thiamine
Neuropathy	B12, thiamine (Wernicke), copper (rarely pyridoxine, folate, niacin, vitamin E)
Myopathy	Vitamin D, vitamin E
Dementia	Niacin, B12
Amnesia, hallucinations, confabulation	Thiamine (Korsakoff)
Confusion, encephalopathy	Thiamine (Wernicke), B12
Heart	
Cardiomyopathy	Selenium
Heart failure	Thiamine

Source: Shiao, J.

Table 4: Pharmacotherapy After Bariatric Surgery

Increased concentration	Decreased concentration
Atorvastatin short-term 8 weeks ⁴⁹	Atorvastatin long-term 2 years ⁴⁹
Metformin ⁴²	Levothyroxine ³⁸
Morphine ⁵⁰	Cyclosporin ³⁸
Acetaminophen	Phenytoin ³⁸
Moxifloxacin ⁵¹	Rifampin ³⁸
	Sertraline
	SRI (SSRI more likely to decrease than SNRI) reduced at 1 month and then normal at 1 year ⁵²
	Tamoxifen ⁵³

List of medications not to be crushed

Alendronate, bisacodyl, bupropion, ciprofloxacin, diltiazem, dipyridamole/ASA, divalproex, felodipine, ferrous sulfate, fexofenadine, finasteride, glipizide, lansoprazole, lithium, loratadine, metformin, metoprolol, morphine, nifedipine, omeprazole, pantoprazole, phenytoin, piroxicam, prednisolone, pseudoephedrine, rabeprazole, tamsulosin, verapamil³⁹

Source: Shiau, J.

Downloaded from: <https://obesitycanada.ca/guidelines/postop>

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The summary of the Canadian Adult Obesity Clinical Practice Guideline is published in the [Canadian Medical Association Journal](https://www.cma.ca/medical-association-journal), and contains information on the full methodology, management of authors' competing interests, a brief overview of all recommendations and other details. More detailed guideline chapters are published on the Obesity Canada website at www.obesitycanada.ca/guidelines.

Correspondence:
guidelines@obesitynetwork.ca

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