Bariatric Surgery

perioperative and postoperative monitoring

Dr Yavari

2024

- **British Obesity and Metabolic Surgery** Society Guidelines on perioperative and postoperative biochemical monitoring and micronutrient replacement for patients undergoing bariatric surgery—**2020 update**
- GUIDELINES FOR MEDICINES MANAGEMENT FOLLOWING BARIATRIC SURGERY.NHS.2021
- **Guidelines for Perioperative Care** in Bariatric Surgery: Enhanced Recovery After Surgery (ERAS) Society Recommendations: A **2021 Update**

- **Post-bariatric surgery nutritional follow-up in primary care**: a population-based cohort study. British Journal of General Practice, **June 2021**
- Guidelines for the **prescribing of nutritional supplements** post bariatric surgery .NHS. Midlands and Lancashire Commissioning Support Unit, **2023**
- Bariatric Surgery: Post-Operative Management. **Canadian Adult Obesity** Clinical Practice Guidelines.**2020**
- **Practical Recommendations** of the Obesity Management Task Force of the **European** Association for the Study of Obesity for the Post-Bariatric Surgery Medical Management.**2018**

- **2022 American Society for Metabolic and Bariatric Surgery** (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO): **Indications for Metabolic and Bariatric Surgery**
- DERBYSHIRE JOINT AREA PRESCRIBING COMMITTEE (JAPC) **Monitoring and Medication after Bariatric Surgery** .NHS**2017**
- **CLINICAL PRACTICE GUIDELINES FOR THE PERIOPERATIVE NUTRITION**, METABOLIC, AND NONSURGICAL SUPPORT OF PATIENTS UNDERGOING BARIATRIC PROCEDURES – **2019 UPDATE**

- **Current recommendations** for procedure selection in class I and II obesity developed by an expert modifed Delphi consensus**2024**
- Bariatric operations: **Late complications** with subacute presentations.**Uptodate 2024**
- Bariatric surgery for management of obesity: **Indications and preoperative** preparation.**Uptodate 2024**

- 1-Health Risks Associated With Obesity
- 2-Indications
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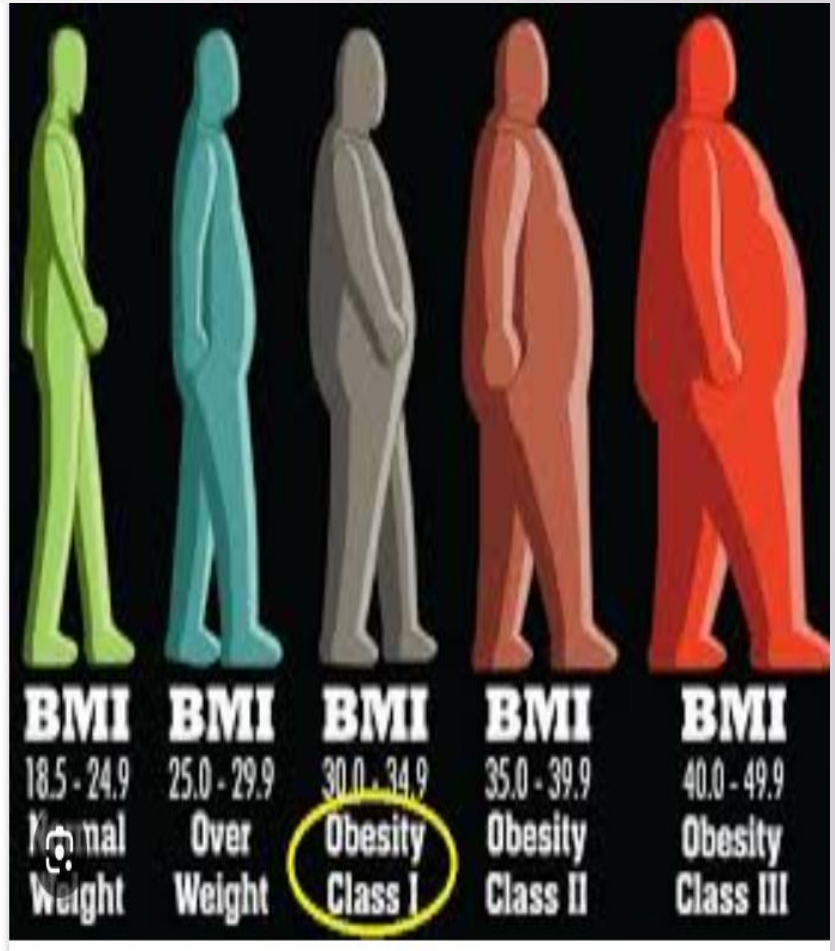
- In the United States, 35 percent of **adults** (roughly 100 million people) and 17 percent of **children** have obesity.
- The surgical procedures performed to manage obesity are collectively referred to as **metabolic** or "bariatric" surgery (from the **Greek words** "**baros**," meaning "**weight**," and "**iatrikos**," meaning ""medicine"



Health Risks Associated With Obesity

- There are several well-established health hazards linked to obesity, including **type 2 diabetes** mellitus, **heart disease**, **stroke**, **cancers** (eg, breast, colon, uterine), **osteoarthritis**, **liver disease**, **obstructive sleep apnea**, and **depression.**

obesity-associated cancer

According to the International Agency for Research on Cancer Handbook Working Group, the **13 types of obesity-associated cancer** include **esophageal** cancer, **renal cell** cancer, breast cancer (in postmenopausal or oophorectomized younger patients), **gastric cardia** cancer, **colon** cancer, **rectal** cancer, **liver** cancer, **gallbladder** cancer, **pancreatic** cancer, **ovarian** cancer, uterine cancer, **thyroid** cancer, and **multiple myeloma.**

Health risks associated with obesity

Coronary artery disease, hypertension
Hyperlipidemia
Type II diabetes mellitus
Asthma, obesity hypoventilation syndrome, obstructive sleep apnea
Gastroesophageal reflux, esophagitis
Fatty liver, cholelithiasis, non-alcoholic steatohepatitis (NASH), cirrhosis
Stress urinary incontinence
Venous stasis disease, deep vein thrombosis, pulmonary embolus, superficial thrombophlebitis
Hernias (inguinal, ventral, umbilical, incisional)
Irregular menstruation, hirsutism, gynecomastia, infertility, polycystic ovary syndrome
Cancer (colon, prostate, uterine, breast)
Infection (cellulitis, panniculitis, postoperative wound infections)
Degenerative joint disease, osteoarthritis
Pseudotumor cerebri (idiopathic intracranial hypertension)
Clinical depression

Courtesy of Vivian Sanchez, MD and Edward Mun, MD.

Graphic 69532 Version 2.0

INDICATIONS

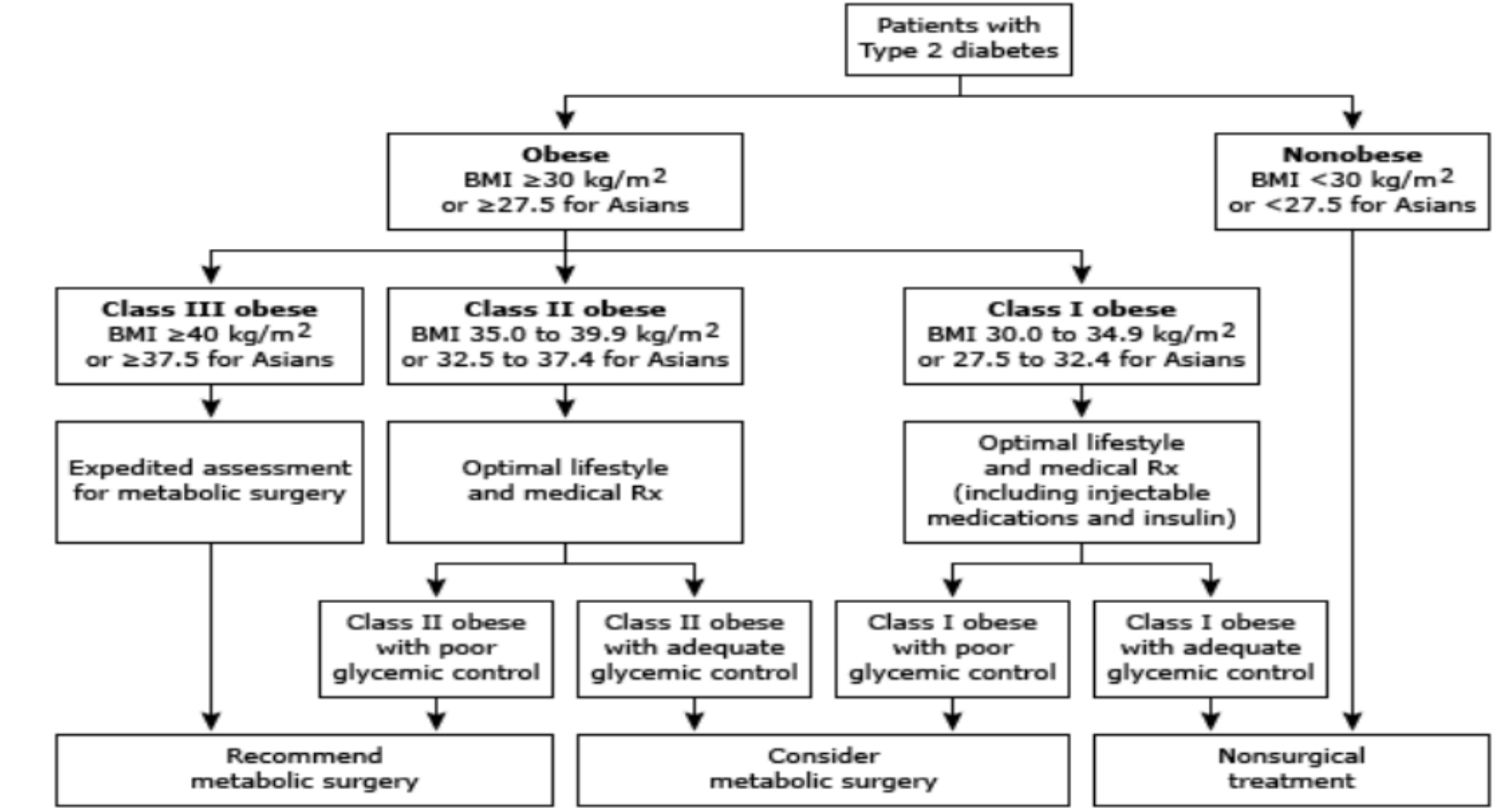
INDICATIONS

- Adults with a body mass index (**BMI) ≥35 kg/m2** regardless of the presence, absence, or severity of comorbidities.
- Adults with a BMI between **30.0 and 34.9 kg/m2 and type 2 diabetes**. Bariatric surgery is now considered to be a treatment option for diabetes in patients with class I obesity who **do not achieve substantial or durable weight loss or comorbidity improvement** with nonsurgical methods

- Adults with a **BMI between 30.0 and 34.9 kg/m2** who **cannot** achieve substantial or sustainable **weight loss or comorbidity** improvement with **nonsurgical** weight loss methods.
- MBS is an effective treatment of clinically **severe obesity** in patients who **need other specialty surgery**, such as **joint arthroplasty**, abdominal wall **hernia** repair, or organ **transplantation**

- Children/adolescents with a **BMI >120% of the 95th** percentile **and** major **comorbidity**, **or a BMI >140% of the 95th** percentile should be considered for **MBS after evaluation by a multidisciplinary team** in a specialty center.

Indications for metabolic surgery in patients with type 2 diabetes



CONTRAINDICATIONS

CONTRAINDICATIONS

- **Untreated** major depression or psychosis
- **Uncontrolled** and untreated **eating disorders** (eg, bulimia)
- Current **drug** and **alcohol** abuse
- **Severe cardiac disease** with prohibitive **anesthetic** risks
- **Severe coagulopathy**
- **Inability** to comply with **nutritional requirements** including **lifelong vitamin** replacement

Types of bariatric procedures

Restrictive
Vertical banded gastroplasty
Laparoscopic adjustable gastric band
Sleeve gastrectomy
Malabsorptive
Jejunoileal bypass
Biliopancreatic diversion
Biliopancreatic diversion with duodenal switch
Combination of restrictive and malabsorptive
Roux-en-Y gastric bypass

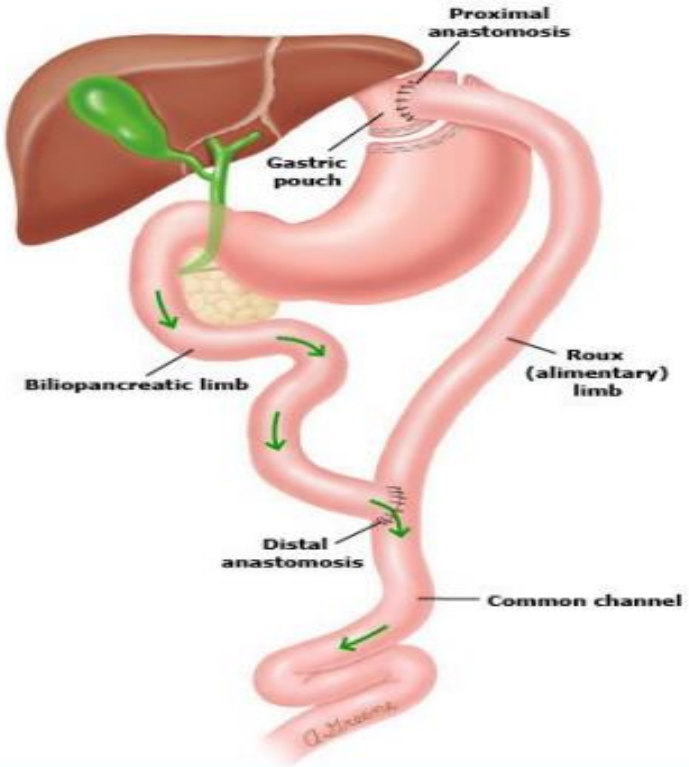
Graphic 59447 Version 1.0

Impact of surgery on absorption

Gastric band	Sleeve gastrectomy	Roux-en-Y Gastric bypass (RYGB)
		
No impact on absorption of nutrients, but patients may experience vomiting or regurgitation and develop food intolerances.	Iron, calcium, vitamin D, vitamin B12, zinc, copper, selenium, vitamin A absorption may be affected.	Iron, calcium, vitamin D, vitamin B12, zinc, copper, selenium, vitamin A absorption may be affected.

Duodenal switch- Iron, calcium, vitamin D, vitamin B12, protein, fat, fat soluble vitamins A, E and K, zinc, copper and selenium absorption are affected.

Components of Roux-en-Y gastric bypass procedure



This figure depicts the components of a Roux-en-Y gastric bypass (RYGB) procedure. RYGB involves the creation of a small gastric pouch and an anastomosis to a Roux limb of jejunum that bypasses 75 to 150 cm of small bowel, thereby restricting food and limiting absorption.

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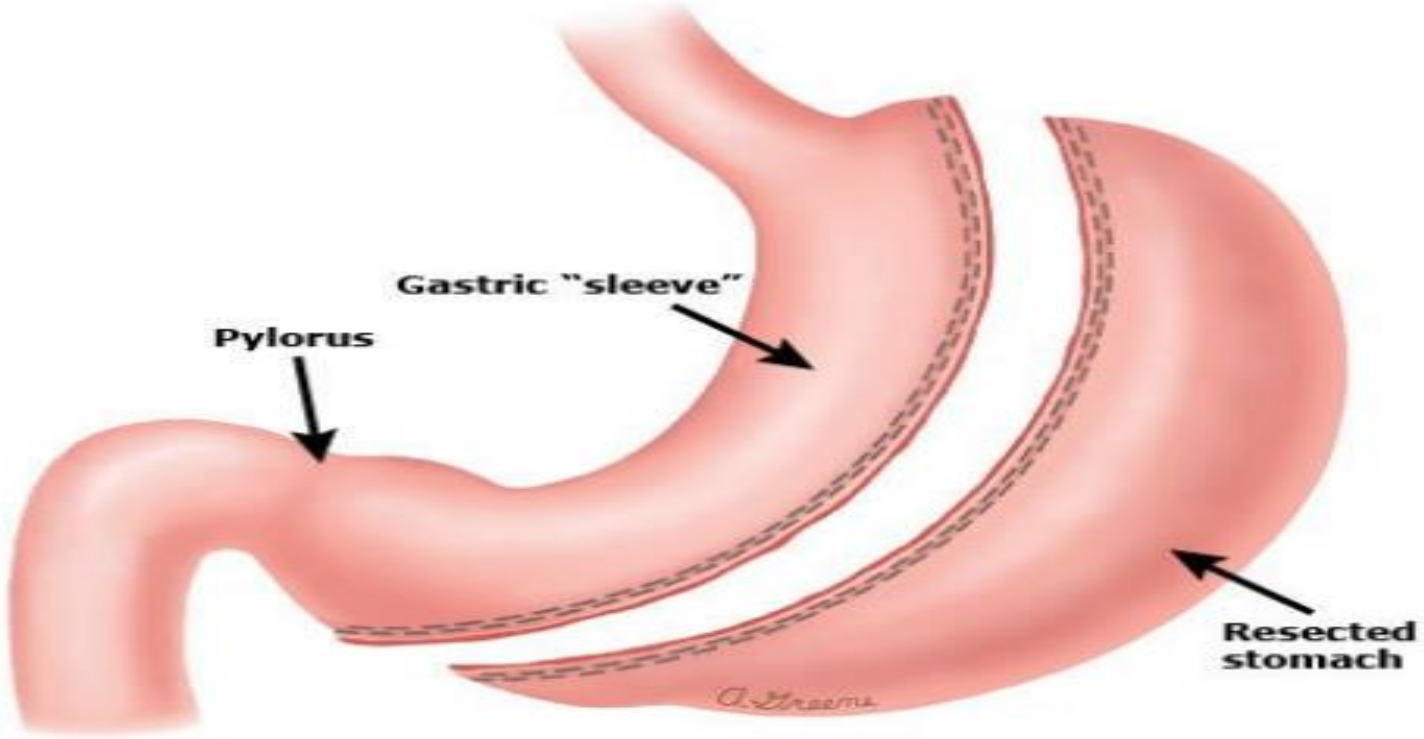
Sleeve gastrectomy



In a sleeve gastrectomy, the majority of the greater curvature of the stomach is removed and a tubular stomach is created. The tubular stomach has a small capacity, is resistant to stretching due to the absence of the fundus, and has few ghrelin (a gut hormone involved in regulating food intake)-producing cells.

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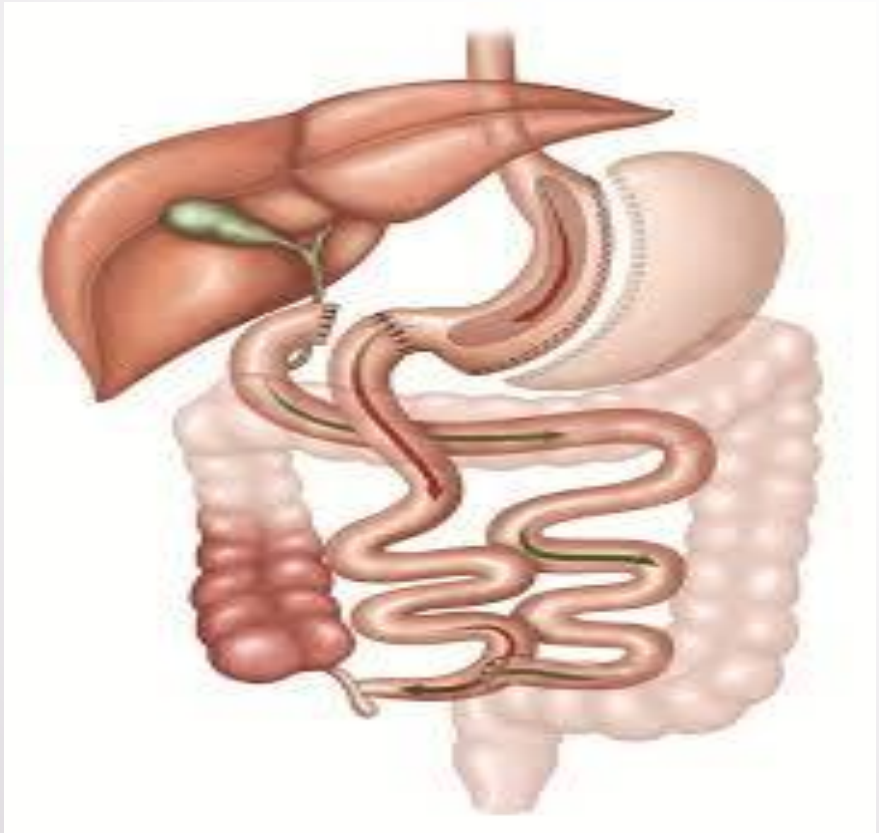
Bilopancreatic diversion



Jejunoileal Bypass

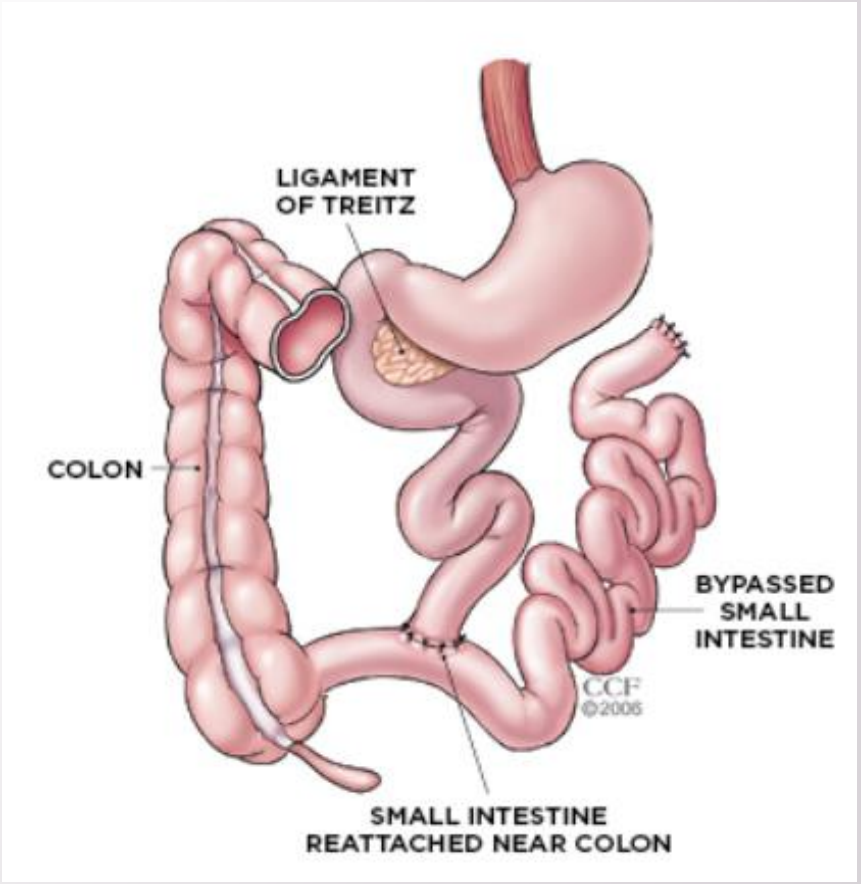


Table 6a

Guiding Bariatric Procedure Selection Based on Risks, Benefits, and Target Weight Loss:
Procedures Endorsed by ASMBS and Possibly Covered by Insurance

Procedure (ref)	Target weight loss (%TBWL)	Favorable aspects	Unfavorable aspects
LAGB (845)	20%-25%	-No anatomic alteration -Removable -Adjustable	-High explant rate -Erosion -Slip/Prolapse
SG (845)	25%-30%	-Easy to perform -No anastomosis -Reproducible -Few long-term complications -Metabolic effects -Versatile for challenging patient populations	-Leaks difficult to manage -Little data beyond 5 years -20%-30% GERD
RYGB (845)	30%-35%	-Strong metabolic effects -Standardized techniques -<5% major complication rate -Effective for GERD -Can be used as second stage after SG	-Few proven revisional options for weight regain -Marginal ulcers -Internal hernias possible -Long-term micronutrient deficiencies
BPD/DS (845)	35%-45%	-Very strong metabolic effects -Durable weight loss -Effective for patients with very high BMI -Can be used as second stage after SG	-Malabsorptive -3%-5% protein-calorie malnutrition -GERD -Potential for internal hernias -Duodenal dissection -Technically challenging -Higher rate of micronutrient deficiencies than RYGB

Abbreviations: ASMBS = American Society of Metabolic and Bariatric Surgery; BMI = body mass index; GERD = gastroesophageal reflux disease; GI = gastrointestinal; HTN = hypertension; IGB = intragastric balloon; LAGB = laparoscopic adjustable gastric banding; LBPD/DS = laparoscopic biliopancreatic diversion with duodenal switch; LRYGB = laparoscopic Roux-en-Y gastric bypass; LSG = laparoscopic sleeve gastrectomy; MetS = metabolic syndrome; NAFLD = nonalcoholic fatty liver disease; NASH = nonalcoholic steatohepatitis; ORC = obesity-related complication; OSA = obstructive sleep apnea; PCOS = polycystic ovary syndrome; TBWL = total body weight loss; T2D = type 2 diabetes; vBLOC = vagal nerve-blocking device.
*Selection of the specific bariatric procedure is done after a decision is made to have a bariatric procedure. Estimate of bariatric surgery numbers can be found at http://asmbs.org/resources/estimate-of-bariatric-surgery-numbers. (Accessed March 25, 2018).

- **STEP 1:** Identify durable target weight loss beyond that achieved with lifestyle and medications to mitigate relevant ORCs -- a primary determinant of an optimal procedure selection:
    - >5%-10% weight loss: T2D, dyslipidemia, HTN, NAFLD, low testosterone, OSA/reactive airway disease, urinary stress incontinence, PCOS
    - >10%-15% weight loss: MetS, prediabetes, NASH, osteoarthritis, GERD, depression (13).
- **STEP 2:** Identify other factors that can affect decision-making, including: durability, eating behaviors, surgeon skills, institutional experience, cardiometabolic effects, prior GI surgery, and GI disease. “Favorable” aspects show key parameters to favor selection of the respective procedure. “Unfavorable” aspects show key parameters against selection of the respective procedure.

Perioperative Assesment

Psychosocial assessment

- **All patients** seeking bariatric surgery should be assessed by a qualified **behavioral health clinician** for **psychosocial** functioning, s**ubstance** abuse, or **maladaptive eating behaviors.**
- **All patients** should also be educated about **new psychosocial problems** that could emerge after bariatric surgery.

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Nutritional assessment

- **All patients** seeking bariatric surgery should be **evaluated** by a registered dietitian for the following:
- Weight history and eating behaviors:Eating and dietary style queries should include for **binge eating**, grazing, **overeating**, **nighttime eating**, and **stress**-related eating patterns, which may identify maladaptive eating styles.

Medication review

- Medications that can **be potentially associated with weight gain** or **increased appetite** include antihypertensives, diabetes medications, hormone therapies, antiseizure medications, antidepressants, mood stabilizers, antipsychotics, migraine medications, and anti-inflammatory .
- **If possible**, a substitution should be made in consultation with the prescriber

Micronutrient deficiency analysis

- A nutrition-focused physical examination and specific bariatric micronutrient (t**hiamin**; **vitamins B12**, **A, E, D, and K**; **folate**; **iron studies**; **ferritin; and calcium**) assessment **should be performed**.
- Most individuals seeking bariatric surgery have at least one micronutrient deficiency .
- **Early diagnosis permits replacement** therapy and improved monitoring postoperatively.

- **Testing for gout** and subsequent **treatment of gout** in **all patients** seeking bariatric surgery are recommended.
- Given the **high likelihood of gouty attacks** postoperatively, **prophylaxis** may be warranted in those who **have a history of gout.**

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- We test for **hypothyroidism** in patients who **have symptoms**.

  We do not obtain thyroidstimulating hormone (**TSH**) in **asymptomatic** patients, as TSH level can be **elevated in euthyroid patients with obesity**.

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Medical assessment

British Obesity and Metabolic Surgery Society **Guidelines**.2020

Preoperative nutritional assessment

- Check full blood count including haemoglobin, **ferritin**, **folate** and vitamin **B12 levels**
- **Vitamin D**, calcium and **parathyroid hormone**

- Consider checking serum **vitamin A levels** in individuals going forward for malabsorptive procedures such as **BPD/DS** or where vitamin A deficiency may be suspected .
- Consider checking serum **zinc**, copper and **selenium** levels in individuals going forward for **malabsorptive procedures** such as **BPD/DS** or if a deficiency is suspected.

- There is **insufficient evidence** to support a recommendation to screen an individual's **thiamine levels** pre surgery; however, some individuals may have low levels Grade

  Magnesium

- There is **insufficient evidence** to support a recommendation to screen an individual's **magnesium** level pre-surgery

- Routinely screen **HbA1c**, **lipid** profile, **liver** and **kidney** function tests and treat as **necessary.**
- Treat and correct nutritional deficiencies preoperatively as individuals have an increased risk of deficiencies postoperatively.

Further assessments

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Obstructive sleep apnea

- The **prevalence of OSA** in individuals with **obesity ranges** from 35 to 94 **percent**, with most studies reporting a rate >60 percent..
- Thus, **screening for OSA** with one of the **questionnaire-based methods** such as STOP-Bang is recommended for **all patients seeking** bariatric surgery.
- Confirmatory tests, such **as polysomnography** (ie, sleep study) or home polygraphy, should be offered to those who are at **high risk of having OSA** based upon the **initial screen.**

Cardiac assessment

- There is **no bariatric-surgery-specific protocol** for preoperative cardiac assessment. Thus, we use the **standard approach**.
- We screen **all patients** with a validated **cardiac risk calculator** (eg, the Revised Cardiac Risk Index), determine their functional capacity, and perform an electrocardiogram.

Gastrointestinal assessment

Depending on the bariatric procedure planned and **symptoms** (eg, reflux, dysphagia), **some patients may benefit from additional assessment** of the upper digestive system, including possible upper gastrointestinal series, upper endoscopy, esophageal pH study, or manometry. This is discussed in topics on individual bariatric procedures.

Cancer screening

- Obesity increases the prevalence of a number of malignancies. As such, patients seeking bariatric surgery should be encouraged to undergo ageappropriate cancer screening such as **colonoscopy** and **mammography.**

PREOPERATIVE INTERVENTIONS

Smoking cessation

- **Tobacco smoking** within **one year prior of bariatric** surgery is known to **increase 30 day mortality** and **major postoperative complications .**
- Smoking cessation programs initiated **four to eight weeks** before **general** and **orthopedic surgery** have reduced complication rates .
- Thus, patients seeking **bariatric surgery** who smoke tobacco or marijuana should be encouraged to stop smoking **at least six weeks** before bariatric surgery.

Alcohol cessation

- In general, it is recommended **that all alcohol** use should **be stopped** before bariatric surgery, but the **exact timing for this is unknown**.
- In patients with a known alcohol abuse diagnosis, alcohol drinking should be stopped for at least one year before surgery .
- Alcohol use or a history of alcohol abuse, though, **are not contraindications** to bariatric surgery .
- Certainly, patients with **known liver disease**, whether or not it is related to alcohol, have a **higher risk of postoperative complications.**

- **Postoperatively** there is a **significant incidence of alcohol abuse after** bariatric surgery, and thus each patient must be informed about this and **monitored for this**.

Estrogen cessation

- Women should **stop taking estrogen-containing oral contraceptives** for one **month before bariatric surgery .**
- They should **consult with their gynecologist** to seek safe **alternatives** such as **progestin-only oral** contraceptives or an **intrauterine device.**

- For **all patients** with **hypercoagulable states** or a **history of a VTE** event, consultation with **hematology/oncology** should be obtained to determine the **type and duration of perioperative thromboprophylaxis.**

Prehabilitation

- rehabilitation programs are **4 to 12 weeks** of supervised **physical exercise**, aggressive **diabetes control**, **alcohol and tobacco cessation**, and **pulmonary interventions** typically given as a part of Enhanced Recovery After Surgery (ERAS) programs.

Table 7 Preprocedure Checklist (including Lifestyle Medicine)[a]	
☑	Complete H & P (obesity-related comorbidities, causes of obesity, weight, BMI, weight-loss history, commitment, and exclusions related to surgical risk)
☑	Routine labs (including fasting blood glucose and lipid panel, kidney function, liver profile, lipid profile, urine analysis, prothrombin time/INR, blood type, CBC
☑	Nutrient screening with iron studies, B_{12} and folic acid (RBC folate, homocysteine, methylmalonic acid optional), and 25-vitamin D (vitamins A and E optional); consider more extensive testing in patients undergoing malabsorptive procedures based on symptoms and risks
☑	Cardiopulmonary evaluation with sleep apnea screening (ECG, CSR, echocardiography if cardiac disease or pulmonary hypertension suspected; deep-venous thrombosis evaluation, if clinically indicated
☑	GI evaluation (*H. pylori* screening in areas of high prevalence; gallbladder evaluation and upper endoscopy, if clinically indicated)
☑	Endocrine evaluation (A1C with suspected or diagnosed prediabetes or diabetes; TSH with symptoms or increased risk of thyroid disease; androgens with PCOS suspicion (total/bioavailable testosterone, DHEAS, Δ_4-androstenedione); screening for Cushing syndrome if clinically suspected (1 mg overnight dexamethasone test, 24-hour urinary free cortisol, 11 PM salivary cortisol)
☑	Lifestyle medicine evaluation: healthy eating index; cardiovascular fitness; strength training; sleep hygiene (duration and quality); mood and happiness; alcohol use; substance abuse; community engagement
☑	Clinical nutrition evaluation by RD
☑	Psychosocial-behavioral evaluation
☑	Assess for individual psychological support/counseling
☑	Document medical necessity for bariatric surgery

☑ Lifestyle medicine evaluation: healthy eating index; cardiovascular fitness; strength training; sleep hygiene (duration and quality); mood and happiness; alcohol use; substance abuse; community engagement
☑ Clinical nutrition evaluation by RD
☑ Psychosocial-behavioral evaluation
☑ Assess for individual psychological support/counseling
☑ Document medical necessity for bariatric surgery
☑ Informed consent
☑ Provide relevant financial information
☑ Continue efforts for pre-operative weight loss
☑ Optimize glycemic control
☑ Pregnancy counseling
☑ Smoking-cessation counseling
☑ Verify cancer screening by primary care physician
Abbreviations: BMI = body mass index; CBC = complete blood count; CSR = Cheyne Stokes respiration; ECG = electrocardiogram; GI = gastrointestinal; INR = international normalized ratio; PCOS = polycystic ovary syndrome; RBC = red blood cell; RD = registered dietician; DHEAS = dehydroepiandrosterone-sulfate; TSH = thyroid-stimulating hormone. [a]Based on information included in Mechanick et al. *Endocr Pract*. 2013;19:337-372 (1).

Post Surgery monitorng

PPI prophylaxis should be considered for at least 30 days after Roux-enY gastric bypass surgery

There is not enough evidence to provide a recommendation of PPI prophylaxis for sleeve gastrectomy, but given the high numbers of patients with gastroesophageal reflux after this procedure, it may be considered for at least 30 days after surgery.

Ursodeoxycholic acid should be considered for **6 months after** bariatric surgery for patients without gallstones at the time of surgery.

- If possible, **liquid oral dosage** forms should be used **instead of solid dosage** forms for at **least two months** after surgery.
- **NSAIDs, salicylates, corticosteroids** and other drugs that may **cause gastric** damage **should be avoided**.
- **Oral contraceptives** should be replaced by **non-oral contraceptives** due to **reduced efficacy** after gastric bypass and bilio-pancreatic diversion.

Box 1. Abbreviated summary of BOMSS post-surgery nutritional guidance for blood tests and supplements[20]

	Annual screening blood tests			Nutritional supplementation		
Tests/ supplements	**LAGB**	**Gastric bypass**	**Sleeve gastrectomy**	**LAGB**	**Gastric bypass**	**Sleeve gastrectomy**
FBC	x	x	x			
U&Es	x	x	x			
LFTs	x	x	x			
Ferritin		x	x			
Folate		x	x			
Calcium		x	x			
Vitamin D		x	x			
PTH		x	x			
Thiamine		S	S			
Vitamin B12		x	x			
Zinc		x				
Copper		x				
Vitamin A		S				
Vitamin E		S				
Vitamin K		S				
Selenium		S				
Multivitamin supplement				x	x	x
Iron supplement					x	x
Folic acid supplement					x	x
Vitamin B12 supplement					x	x
Calcium and vitamin D supplement					x	x

BOMSS = British Obesity and Metabolic Surgery Society. FBC = full blood count. LAGB = laparoscopic adjustable gastric banding. LFTs = liver function tests. PTH = parathyroid hormone. S = measure if concerning signs or symptoms. U&Es = urea and electrolytes.

Table 6. Minimal periodic surveillance for nutritional deficiencies after bariatric surgery

	AGB	SG	RYGB	BPD – BPD/DS
Timing	every 6 months in the first year every 12 months thereafter	every 3–6 months in the first year every 12 months thereafter	every 3–6 months in the first year every 12 months thereafter	every 3 months in the first year every 6–12 months thereafter
Assessment	CBC, platelets electrolytes iron, ferritine vitamin B12 folate vitamin D PTH	CBC, platelets electrolytes iron, ferritine vitamin B12 folate vitamin D PTH	CBC, platelets Electrolytes iron, ferritine vitamin B12 folate vitamin D PTH 24-H U-calcium osteocalcin	CBC, platelets electrolytes iron, ferritine vitamin B12 folate vitamin D PTH 24-H U-calcium osteocalcin vitamin A vitamin E INR albumin prealbumin

AGB = Adjustable gastric banding; SG = sleeve gastrectomy; RYGB = gastric bypass; BPD = biliopancreatic diversion; BPD/DS = biliopancreatic diversion with duodenal switch. CBC = complete blood count; PTH = intact parathyroid hormone; 24-H U-calcium = 24-hour urinary calcium (modified [39]).

Blood Test	Procedure		
	Laparoscopic Adjustable Gastric Band	Laparoscopic Sleeve Gastrectomy	Roux-en-Y Gastric Bypass and duodenal switch
Calcium	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Ferritin	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Folate	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Full Blood Count	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
HbA1c or Fasting Blood Glucose (patients with preoperative diabetes)	Monitor as appropriate	Monitor as appropriate	Monitor as appropriate
Lipid Profile	Monitor in those with dyslipidaemia	Monitor in those with dyslipidaemia	Monitor in those with dyslipidaemia
Liver Function Tests	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Parathyroid Hormone	Check if not done so prior to surgery	Check if not done so prior to surgery	Check if not done so prior to surgery
Selenium	N/A	If clinically indicated*	Annually
		Routine blood	Routine blood

Thiamine	3, 6, 12 months after surgery, then annually	Routine blood monitoring is not required – only in patients with prolonged vomiting	Routine blood monitoring is not required – only in patients with prolonged vomiting
Urea and Electrolytes	Annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Vitamin A	N/A	Measure if concerns regarding steatorrhea or symptoms of vitamin A deficiency e.g., night blindness	Monitor every three months for the first year then annually
Vitamin B12	N/A	6, 12 months after surgery, then annually – not required if the patient is receiving B12 injections	6, 12 months after surgery, then annually – not required if the patient is receiving B12 injections
Vitamin D	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Vitamin E and K	N/A	Annually	Annually
Zinc, Copper	N/A		Annually

* GP to be informed by the specialist service if indicated.

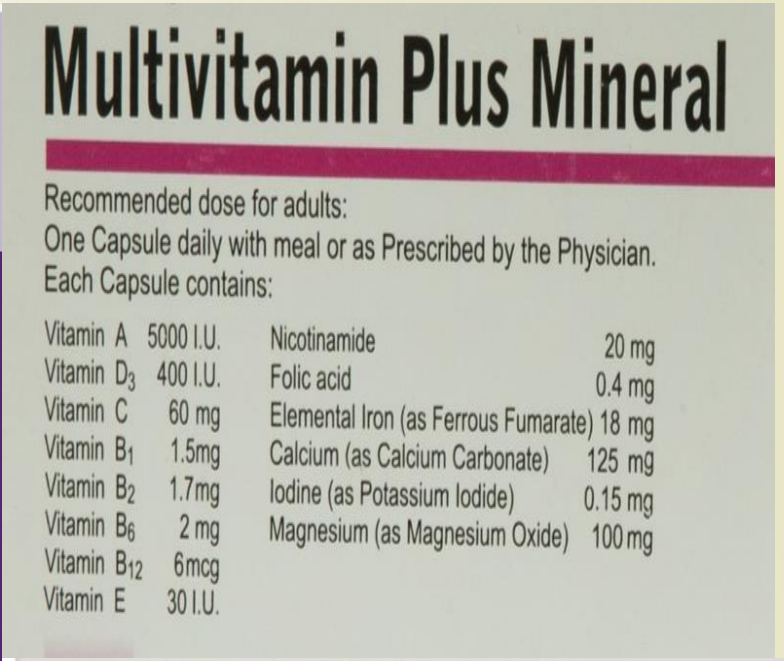
Nutritional Deficiency	Notes
Protein malnutrition	May present as oedema several years post-surgery Requires urgent referral back to the bariatric team
Anaemia	Iron deficiency (rule out and investigate other potential causes, such as blood loss) Folate deficiency Vitamin B12 deficiency Less common deficiencies such as zinc, copper, and selenium are a potential cause of unexplained anaemia Some patients may need parenteral iron or blood transfusions if oral iron does not correct the deficiency
Calcium and vitamin D deficiency	It is recommended that vitamin D should be replaced if deficiency is severe – aim for levels of 75 - 250nmol/L post weight-loss surgery.

Vitamin A deficiency	Suspect in patients with changes in night vision Patients with steatorrhea or those who have had a duodenal switch are at high risk
Zinc, copper and selenium deficiency	Unexplained anaemia, poor wound healing, hair loss, neutropenia, peripheral neuropathy and cardiomyopathy are potential symptoms Ask about over-the-counter supplements and liaise with bariatric unit, as zinc supplements can induce copper deficiency and vice versa
Thiamine deficiency	Suspect in patients with poor intake, persistent regurgitation or vomiting This may be caused by anastomotic stricture in the early postoperative phase, food intolerances or an over tight band Start thiamine supplementation immediately and refer urgently to the local bariatric unit due to brisk of Wernicke's encephalopathy Do not give sugary drinks as they may precipitate Wernicke's encephalopathy

Table 4: Potential nutritional deficiencies post-bariatric surgery [5]

Post-bariatric surgery nutrition and exercise: eat 3–5 small meals; chew food slowly; aim for minimum 60 g protein/day (LS/RYGB) or 80–120 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.

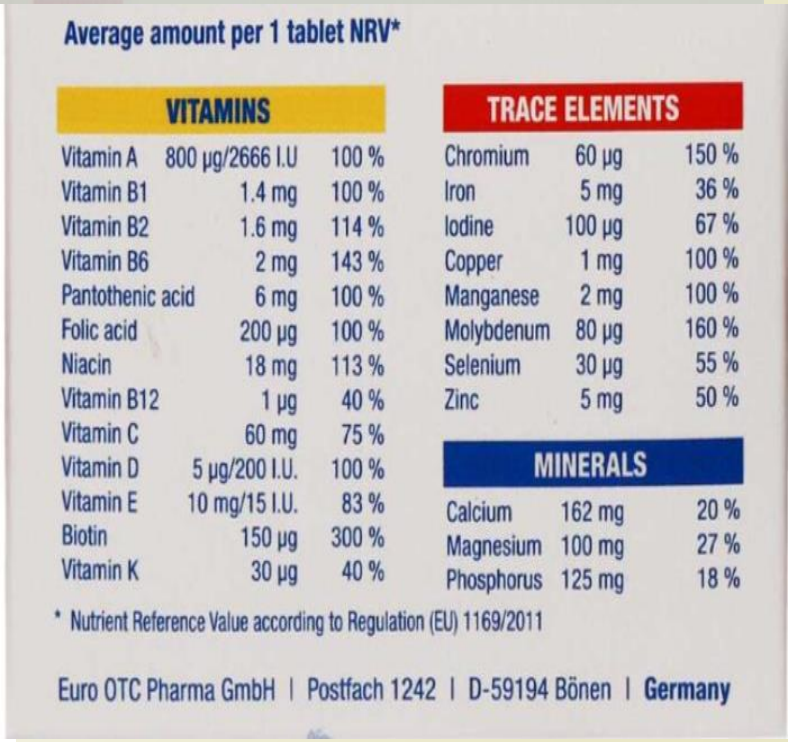
Vitamins and minerals	Daily prevention recommendation post-bariatric surgery (solid line means difference in dosing; — means no evidence of difference in dosing between the types of bariatric surgery)			Description of supplement with suggested timing (most patients will require complete multivitamins [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		Take complete MVs at breakfast. 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. Generally, patients will need two complete OTC MV day to reach the daily recommendations post-bariatric surgery. The ratio of zinc:copper should remain 8–15 mg:1 mg.
Vitamin B3 (Niacin)		40 mg		
Pantothenic acid (B5)		20 mg		
Vitamin B6		4 mg		
Biotin		60 mcg		
Vitamin C		120 mg		



Multivitamin Plus Mineral

Recommended dose for adults:
One Capsule daily with meal or as Prescribed by the Physician.
Each Capsule contains:

Vitamin A	5000 I.U.	Nicotinamide	20 mg
Vitamin D_3	400 I.U.	Folic acid	0.4 mg
Vitamin C	60 mg	Elemental Iron (as Ferrous Fumarate)	18 mg
Vitamin B_1	1.5mg	Calcium (as Calcium Carbonate)	125 mg
Vitamin B_2	1.7mg	Iodine (as Potassium Iodide)	0.15 mg
Vitamin B_6	2 mg	Magnesium (as Magnesium Oxide)	100 mg
Vitamin B_{12}	6mcg		
Vitamin E	30 I.U.		



Average amount per 1 tablet NRV*

VITAMINS		
Vitamin A	800 µg/2666 I.U	100 %
Vitamin B1	1.4 mg	100 %
Vitamin B2	1.6 mg	114 %
Vitamin B6	2 mg	143 %
Pantothenic acid	6 mg	100 %
Folic acid	200 µg	100 %
Niacin	18 mg	113 %
Vitamin B12	1 µg	40 %
Vitamin C	60 mg	75 %
Vitamin D	5 µg/200 I.U.	100 %
Vitamin E	10 mg/15 I.U.	83 %
Biotin	150 µg	300 %
Vitamin K	30 µg	40 %

TRACE ELEMENTS		
Chromium	60 µg	150 %
Iron	5 mg	36 %
Iodine	100 µg	67 %
Copper	1 mg	100 %
Manganese	2 mg	100 %
Molybdenum	80 µg	160 %
Selenium	30 µg	55 %
Zinc	5 mg	50 %

MINERALS		
Calcium	162 mg	20 %
Magnesium	100 mg	27 %
Phosphorus	125 mg	18 %

* Nutrient Reference Value according to Regulation (EU) 1169/2011

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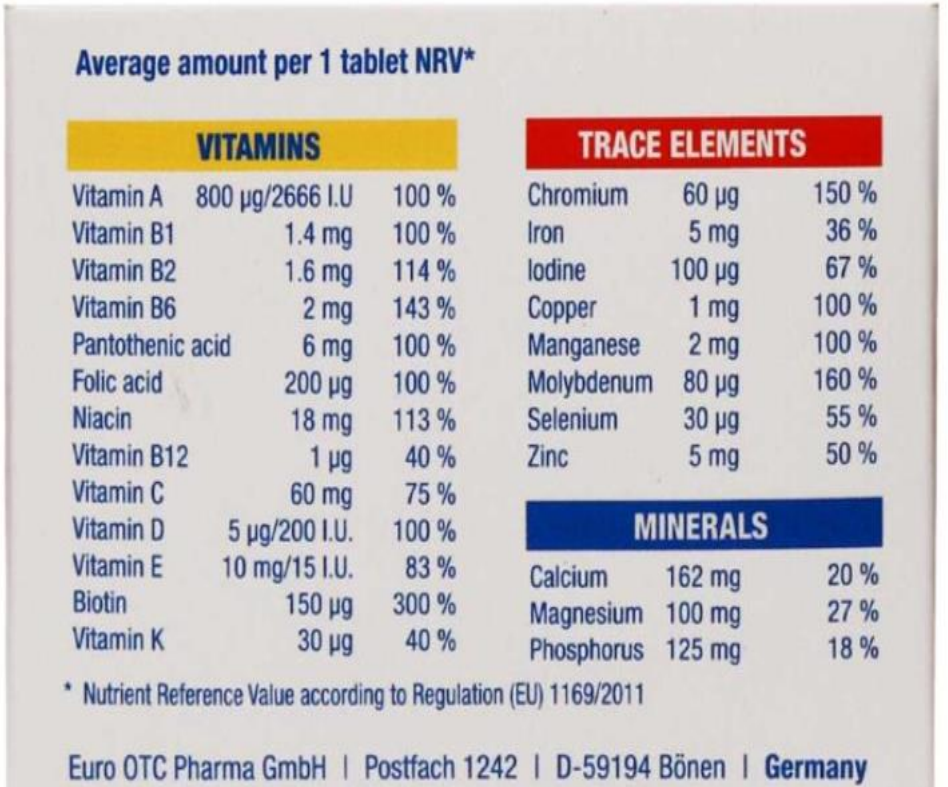
Selenium		140 mcg	
Magnesium		400 mg	
Manganese		4 mg	
Chromium		120 mcg	
Molybdenum		50 mcg	
Zinc	8–11 mg	8–22 mg	16–22 mg
Copper	1 mg	1–2 mg	2 mg
Vitamin A	5000–10000 IU	5000–10000 IU	10000 IU
Vitamin K	90–120 mcg	90–120 mcg	300 mcg
Vitamin E		15mg	
Folic acid		400–800 mcg	
Folic acid (pre-conception to 12 weeks GA)		1000 mcg	
Folic acid from > 12 wks to breastfeeding/ or 4–6 wks postpartum		800–1000 mcg Duodenal Switch	

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.

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.



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Ingredients

Beta-Carotene 2700 mcg, Vitamin C 108 mg, Vitamin D3 60 mcg, Vitamin E 21 mg, Vitamin K2 120 mcg, Vitamin B1 10 mg, Vitamin B2 6 mg, Vitamin B3 30 mg, Vitamin B6 12 mg, Folate 800 mcg, Vitamin B12 1000 mcg, Biotin 600 mcg, Vitamin B5 15 mg, Iron 36 mg, Iodine 150 mcg, Magnesium 24 mg, Zinc 11 mg, Selenium 100 mcg, Copper 1.6 mg, Manganese 2.4 mg, Chromium 63 mcg, Molybdenum 75 mcg, Silicon 3.5 mg, Organic Fruit & Vegetable Blend (Apple Fiber, Mango, Orange, Spinach, Carrot, Kale) 30 mg

Important information

Ingredients

Vitamin A (3,000 mcg), Vitamin C (130 mg), Vitamin D (75 mcg), Vitamin E (40.2 mg), Vitamin K (120 mcg) , Thiamin (20 mg), Riboflavin (Vitamin B2) (12 mg), Niacin (40 mg), Vitamin B6 (12 mg), Folate (1,333 mcg) (800 mcg folic acid), Vitamin B12 (1000 mcg), Biotin (600 mcg), Pantothenic Acid (20 mg), Iron (45 mg), Iodine (150 mcg), Magnesium (100 mg), Zinc (15 mg), Selenium (100 mcg), Copper (2 mg), Manganese (2 mg), Chromium (100 mcg), Molybdenum (75 mcg), hypromellose, stearic acid, magnesium stearate, and microcrystalline cellulose.

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 Low risk (men and patients without history of anemia)	18 mg			Take before bed. Do not take with calcium as absorption blocked.
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): • Ferrous sulphate 300 mg (60 mg), • Ferrous gluconate 300 mg (35 mg), and • 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 First year post-op Thereafter	Every 3–6 months Yearly	Every 3-6 months Yearly	Every 3 months Every 6-12 months	In pregnancy, labs should be monitored each trimester: CBC, ferritin, albumin, B12, 25(OH) D, calcium, PTH, folate. For hypoabsorptive surgeries add zinc, copper, vitamin A (for duodenal switch possibly add vitamin E and vitamin K) 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: Shiau, J.

Table 4: Pharmacotherapy After Bariatric Surgery

Increased concentration	Decreased concentration
Atorvastatin short-term 8 weeks[64]	Atorvastatin long-term 2 years[64]
Metformin[42]	Levothyroxine[38]
Morphine[65]	Cyclosporin[38]
Acetaminophen	Phenytoin[38]
Moxifloxacin[66]	Rifampin[38]
	Sertraline
	SRI (SSRI more likely to decrease than SNRI) reduced at 1 month and then normal at 1 year[67]
	Tamoxifen[68]

Treatment For Dificiency

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, fortified breakfast cereals	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) 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
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	

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, hyperkera-tinization 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 *im* for 3 days followed by 50000IU/day *im* 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. im: 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: 4–62%; 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 *im*

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 50000 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).[63] 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: Shiau, J

Table 9
Postprocedure Checklist[a]

Checklist Item		LAGB	SG	RYGB	BPD/DS
Early postoperative care					
✓	monitored telemetry at least 24 h if high risk for MI	✓	✓	✓	✓
✓	protocol-derived staged meal progression supervised by RD	✓	✓	✓	✓
✓	healthy eating education by RD	✓	✓	✓	✓
✓	multivitamin plus minerals (# tablets for minimal requirement)	1	2	2	2
✓	elemental calcium (as calcium citrate)	1,200-1,500 mg/d	1,200-1,500 mg/d	1,200-1,500 mg/d	1,800-2,400 mg/d
✓	vitamin D, at least 3,000 units/d, titrate to >30 ng/mL	✓	✓	✓	✓
✓	vitamin B_{12} as needed for normal range levels	✓	✓	✓	✓
✓	maintain adequate hydration (usually >1.5 L/d PO)	✓	✓	✓	✓
✓	monitor blood glucose with diabetes or hypoglycemic symptoms	✓	✓	✓	✓
✓	pulmonary toilet, spirometry, DVT prophylaxis	✓	✓	✓	✓
✓	if unstable, consider PE, IL	PE	PE	PE/IL	PE/IL
✓	if rhabdomyolysis suspected, check CPK	✓	✓	✓	✓

Table 9
Postprocedure Checklist[a]

Checklist Item		LAGB	SG	RYGB	BPD/DS
✓	visits: initial, interval until stable, once stable (months)	1, 1-2, 12	1, 3, 6, 12	1, 3, 6-12	1, 3, 6
✓	monitor progress with weight loss and evidence of complications each visit	✓	✓	✓	✓
✓	SMA-21, CBC/plt with each visit (and iron at baseline and after as needed)	✓	✓	✓	✓
✓	avoid nonsteroidal anti-inflammatory drugs	✓	✓	✓	✓
✓	adjust postoperative medications	✓	✓	✓	✓
✓	consider gout and gallstone prophylaxis in appropriate patients	✓	✓	✓	✓
✓	need for antihypertensive therapy with each visit	✓	✓	✓	✓
✓	lipid evaluation every 6-12 months based on risk and therapy	✓	✓	✓	✓
✓	monitor adherence with physical activity recommendations	✓	✓	✓	✓
✓	evaluate need for support groups	✓	✓	✓	✓

Table 9
Postprocedure Checklist[a]

Checklist Item		LAGB	SG	RYGB	BPD/DS
✓	visits: initial, interval until stable, once stable (months)	1, 1-2, 12	1, 3, 6, 12	1, 3, 6-12	1, 3, 6
✓	bone density (DXA) at 2 years	✓	✓	✓	✓
✓	24-h urinary calcium excretion at 6 months and then annually[b]	x	x	x	✓
✓	B_{12} (annually; MMA and HCy optional; then q 3-6 months if supplemented)	✓	✓	✓	✓
✓	folic acid (RBC folic acid optional), iron studies, 25-vitamin D, iPTH	x	x	✓	✓
✓	vitamin A (initially and q 6-12 months thereafter)	x	x	optional	✓
✓	copper, zinc, selenium evaluation with specific findings	x	x	✓	✓
✓	thiamine evaluation with specific findings	✓	✓	✓	✓
✓	consider eventual body contouring surgery	✓	✓	✓	✓
✓	lifestyle medicine evaluation: healthy eating index; cardiovascular fitness; strength training; sleep hygiene (duration and quality); mood and happiness; alcohol use; substance abuse; community engagement	✓	✓	✓	✓
✓	hemoglobin A1c, TSH evaluation in long-term follow-up	✓	✓	✓	✓

COMPLICATIONS COMMON TO ALL PROCEDURES

Cholelithiasis

- Gallstones can develop after bariatric surgery due to an increased biliary cholesterol concentration following rapid **weight loss**, gallbladder **hypomotility** secondary to **vagal nerve resection** and a **decreased cholecystokinin.**

- After a mean follow-up of **29 months** after a variety of bariatric operations, cholelithiasis develops in as many as 20.7 percent of patients, and 8.2 percent of patients become symptomatic, which is three times higher than in the general population.
- Gallstones can develop after all bariatric operations.

- The decision to perform a cholecystectomy at the time of bariatric surgery is controversial.
- Some surgeons recommend performing cholecystectomy at the time of bariatric surgery if a patient has **symptomatic gallstones preoperatively**.
- The **frequency of cholelithiasis** can be reduced from 25 to 7 percent with a six-month course of ursodeoxycholic acid (UDCA; ursodiol, a synthetic bile salt) at 600 mg/day given **prophylactically** after weight-loss surgery.

- Patients who develop choledocholithiasis (stones in the common bile duct) after gastric bypass can be **challenging to treat** with endoscopic retrograde cholangiopancreatography (**ERCP**) due to the **Roux-en-Y** configuration .
- As a result, **surgery** or **transhepatic percutaneous** access may be required. This is discussed in detail elsewhere.

Ventral incisional hernia

- Severe obesity is associated with increased intra-abdominal pressure, and thus, a high risk of hernia development after any **abdominal surgery**.
- Patients are 10 times more likely to develop a hernia after open than laparoscopic surgery.
- Other risk factors include malnutrition, prior abdominal surgery, and a body mass index greater than 60 kg/m2.

- Incisional hernias present with an enlarging bulge, pain, or obstructive symptoms.
- Indications for early surgical repair include significant pain, bowel obstruction, and rapid enlargement of the hernia.

Change in bowel habits

- Patients can expect some change in bowel habits after bariatric surgery, although significant alterations can negatively impact quality of life.
- In general, loose stool and diarrhea are more common after biliopancreatic diversion (BPD) and RYGB, while constipation is more common after restrictive procedures such as adjustable gastric banding.

- Changes in bowel habits after bariatric surgery may be transient. In another study, 573 patients who underwent all types of bariatric surgery reported worsened bowel function at two weeks after surgery.
- However, by three months, the reported bowel function was already better than the baseline, and the improvement was sustained to two years.

PROCEDURE-SPECIFIC COMPLICATIONS

Roux-en-Y gastric bypass

- Roux-en-Y gastric bypass (RYGB) involves the creation of a small gastric pouch and an anastomosis to a Roux limb of jejunum that bypasses 75 to 150 cm of small bowel, thereby **restricting food** and **limiting absorption .**
- This procedure is **the second most common weight** loss procedure performed **after sleeve** gastrectomy. The complications of RYGB are diverse and vary based upon the specific technique.

Dumping syndrome

- In that cohort, the total prevalence of one or both types of symptoms was 12.6 percent .
- Patients who were **younger than 35 years** of age or **had a body mass index** (BMI)<25Kg/m2were more likely to be **symptomatic** than those who were older or had a higher BMI.

Early dumping syndrome

- Early dumping syndrome has a rapid onset, usually within one hour of **eating**.
- It is the result of **rapid emptying of food** into the **small bowel**. Due to the **hyperosmolality** of the food, **rapid fluid shifts from the plasma** into the bowel occur, resulting in **hypotension** and a **sympathetic nervous system response**.

- Patients often present with gastrointestinal symptoms (abdominal **pain**, **bloating**, borborygmi, **nausea**, and **diarrhea**) and vasomotor symptoms (flushing; palpitations; perspiration; tachycardia; hypotension; fatigue; a desire to lie down; and, rarely, syncope)

- Patients should avoid foods high in simple sugar content and **replace** them with a diet consisting of **high-fiber**, **complex carbohydrate**, and **protein-rich** foods.
- Behavioral modification, such as **small**, **frequent** meals, **slow eating**, **chewing** well, and **separating solid** from **liquid** intake by 30 minutes, is also advocated.
- Usually, **early dumping** is self-limiting and resolves within 7 to 12 weeks.

- Dietary supplements that increase the **viscosity** of food (such as **guar gum**, **pectin**, and **glucomannan**) or pharmacologic agents (such as **acarbose**) are a good second-line treatment for symptoms of dumping syndrome **after** dietary modification.

Postprandial hyperinsulinemic hypoglycemia

- Previously referred to as "late dumping syndrome," **postprandial hyperinsulinemic hypoglycemia** (PHH) is a rare complication of bariatric surgery.
- It occurs in 0.1 to 0.3 percent of patients, most commonly after gastric bypass.

- Symptoms of PHH, including **dizziness**, **fatigue**, **diaphoresis**, and **weakness**, usually occur one to three hours after ingesting a carbohydrate-rich meal, typically **months to years after surgery**, and are associated with **documented hypoglycemia .**
- The pathophysiology of PHH is **not fully understood** but likely includes alterations in **multiple hormonal** and glycemic patterns (eg, increase in incretin levels).

- Most patients with PHH can be managed with the **same dietary** modification suggested above for **early dumping** syndrome.
- Patients who are refractory to dietary modification can be treated with medications (eg, **nifedipine**, **acarbose**, **diazoxide**, or **octreotide**), gastrostomy tube feeding into the remnant stomach, or revisional bariatric surgery. Pancreatic resection has unproven benefit and should not be performed for PHH.

Nephrolithiasis and renal failure

- — RYGB has been linked to metabolic changes that can alter urine chemistry profiles, resulting in **higher calcium oxalate supersaturation** and **urine oxalate**, **lower citrate**, and **lower volume**.
- Consequently, patients have a **higher risk** of developing nephrolithiasis after RYGB.

- While uncommon, increased absorption of calcium oxalate can also lead to deposition in the **renal parenchyma**, resulting in **oxalate nephropathy** and **renal failure .**
- **Renal biopsies** revealed diffuse tubular degenerative changes, abundant tubular calcium oxalate deposits, and varying degrees of tubulointerstitial scarring. Effective **medical therapy is ,**although anecdotal reports have shown that **reversing the gastric** bypass may help.

Metabolic bone changes and secondary hyperparathyroidism

- Vitamin D deficiency and secondary hyperparathyroidism already exists in 60 to 84 percent and 42 to 49 percent of patients seeking bariatric surgery, respectively .
- RYGB further exacerbates calcium deficiency and reduces bone mineral density by reducing dietary calcium intake, **calcium absorption** (from bypassing the proximal small intestine and reducing gastric acidity), and reducing mechanical loading (from weight loss).

- Reducing the **bone mineral density** of the skeletal system can increase the **risk of fracture .**
- The increased risk of fractures varies from 25 percent to 2.6-fold, depending on studies .
- Treatment options include **calcium/vitamin D** supplementation and **exercise.**

- The prevalence of secondary hyperparathyroidism (SHPT) is high in patients with **obesity before bariatric surgery**, which is related to **vitamin D deficiency**.
- The prevalence of **SHPT increased continually** along with the time **after** bariatric surgery, especially in patients receiving single anastomosis gastric bypass, followed by RYGB .
- A meta-analysis of nine studies found that the risk of SHPT after RYGB markedly increased after two years of followup.

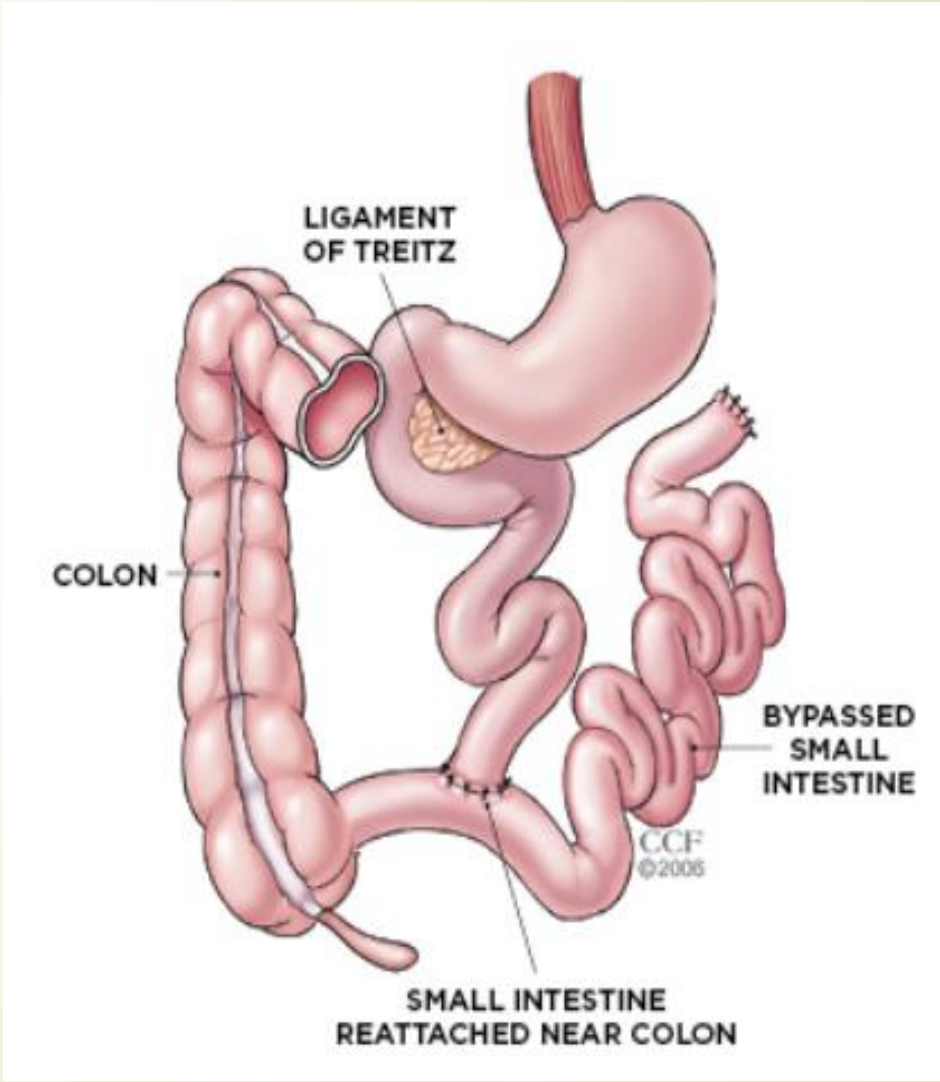
Hyperammonemic encephalopathy

- — Hyperammonemic encephalopathy has been reported in **case reports** of patients who are failing to thrive after complicated gastrointestinal surgeries that can include RYGB .
- The underlying etiologies are incompletely understood but include both genetic (eg, **proximal urea cycle disorders**) and nongenetic causes (eg, **splenorenal shunt**). The typical clinical features include hypoalbuminemia, hypoglycemia, low plasma zinc level, and other nutritional deficiencies.

- The key to diagnosis is the early assessment of plasma ammonia levels in such patients with **normal hepatic function** but characteristic symptoms of encephalopathy .
- **Once hyperammonemic** encephalopathy is diagnosed, it can be treated with **supportive** and **medical care to reduce ammonia levels**.

Jejunoileal bypass

- — Jejunoileal bypass (JIB) is a purely malabsorptive procedure that was popular in the 1960s and 1970s. The procedure produces **significant weight** loss by creating a surgical short bowel syndrome .
- JIB is **no longer used** today because of a 50 percent morbidity rate and a 10 percent mortality rate.



- Over half of the patients who underwent JIB developed diarrhea and **electrolyte imbalances** ,and these problems could persist more than five years after surgery. Patients who previously underwent JIB should be **followed carefully for signs of complications**, including arthritis, protein malnutrition, vitamin deficiencies, cirrhosis, nephrolithiasis with oxalate stones, and renal failure.

Cirrhosis

- Hepatic abnormalities that may lead to cirrhosis can occur in up to 40 percent of patients and may persist or progress despite reversal in more than one-third of patients .
- Progressive liver injury appears histologically as increasing **steatosis, lobular lymphocytic inflammation**, **pericellular fibrosis**, **Mallory bodies**, and **deranged architecture**, all features resembling those **seen in alcoholic liver** disease.

- Some patients have progressed to decompensated cirrhosis requiring liver transplantation .
- If not already performed, reversal of the jejunoileal bypass at the time of transplant should be considered.
- **Reversal prior to transplant may not be feasible** because of the risk of precipitating **hepatic decompensation in patients with advanced liver** disease. Patients who do not undergo reversal at the time of transplant should be monitored closely, with reversal performed in those who develop progressive liver injury.

Pregnancy after bariatric surgery

- Pregnancy is **not recommended** in the **first 12–18 months** following bariatric surgery.
- **Micronutrient supplementation** should be provided to all women who are pregnant following bariatric surgery, in the form of a **prenatal multivitamin** preparation, **B12 injections** and **oral calcium supplements.**

- Screening for **gestational diabetes** should be offered, however the conventional **oral glucose tolerance test** should be **avoided**.
- **Serial capillary glucose** monitoring should be used as an alternative.

- Women presenting with **abdominal pain** in pregnancy should be offered **urgent expert assessment**, particularly for complications related to the primary bariatric surgical procedure.

Table 11. Effects of bariatric surgery on maternal and foetal outcomes [112–114]

Maternal outcomes	Risk	Foetal outcomes	Risk
Gestational diabetes	reduced	small for gestational age	increased
Gestational hypertension	reduced	premature labour	increased
Miscarriage	limited data	low birthweight	increased
Post-partum haemorrhage	limited data	large for gestational age	reduced
Pre-eclampsia	reduced	perinatal mortality	no difference

- Pre-Conception Care: In preparation for pregnancy, women should take an additional **400 µg of folic acid** in the pre-conception period, and women with a **BMI** that remains in **the obese range** or with **type 2 diabe**tes should take **5 mg/day until the 12th week** of pregnancy .
- In addition, women should be advised to **avoid** multivitamins containing **vitamin A** in the retinol form.

- **Routine ultrasounds** should be performed at weeks 12 and 20.
- Bariatric surgery should be viewed **as a risk factor for IUGR**, an additional growth scan should be performed and the subsequent need for further growth surveillance should be determined at that point.

Table 12. Recommended nutritional screening and supplementation during pregnancy [6, 104, 121]

Micronutritional marker	Laboratory testing (each trimester)	Dose for supplementation
Vitamin B1	serum B1 levels	prenatal multivitamins (preparations may vary by country)
Vitamin K	serum vitamin K	prenatal multivitamins (preparations may vary by country)
Vitamin A	serum vitamin A	prenatal multivitamins (preparations may vary by country)
Zinc	serum zinc levels	prenatal multivitamins (preparations may vary by country)
Vitamin D	serum 25-hydroxy vitamin D	cholecalciferol 1,000 IU daily (higher doses may be required in deficient states)
Folate	serum folate	400 µg or 5 mg if type 2 diabetes or BMI >30 until 12th week
Iron	full blood count, serum ferritin, serum iron and iron binding capacity	ferrous sulphate 200 mg orally 2-3 times daily

Vitamin D	serum 25-hydroxy vitamin D	cholecalciferol 1,000 IU daily (higher doses may be required in deficient states)
Folate	serum folate	400 µg or 5 mg if type 2 diabetes or BMI >30 until 12th week
Iron	full blood count, serum ferritin, serum iron and iron binding capacity	ferrous sulphate 200 mg orally 2-3 times daily
Calcium	serum adjusted calcium, parathyroid hormone	calcium citrate 1,000–1,200 mg
Vitamin B12	full blood count, Serum vitamin B12	1 mg intramuscular injection every 12 weeks
Protein	serum albumin	60 g protein daily as part of balanced diet