

Metabolic Sequelae of Bariatric Surgery

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OUTLINE

- Introduction
- Indications and metabolic benefits of bariatric surgery
- Obesity Paradox
- Micronutrients deficiencies
- Macronutrients deficiencies
- Pregnancy state
- Hypoglycemia post bariatric surgery
- Supplementation protocols

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Introduction



- Obesity epidemic continues
- More than one-third of adults in USA considered obese in 2009-2010, as defined by a body mass index (BMI) ≥ 30 kg/m²
- Popularity of bariatric surgery rises

Role of Bariatric Surgery in Managing Obesity and Associated Metabolic Conditions

- It was shown that bariatric surgery causes significant weight loss and is more effective than nonsurgical interventions (lifestyle and medications).
- Treat or prevent obesity-related comorbidities (e.g., diabetes, hypertension, cardiovascular disease, obstructive sleep apnea)
- The mechanism for postoperative metabolic improvements has not been fully elucidated and may be, in part, independent of weight loss

Candidates for bariatric surgery

Body mass index (BMI) ≥ 40 kg/m² or BMI ≥ 35 kg/m²
with significant obesity-related co-morbidities

Acceptable operative risk

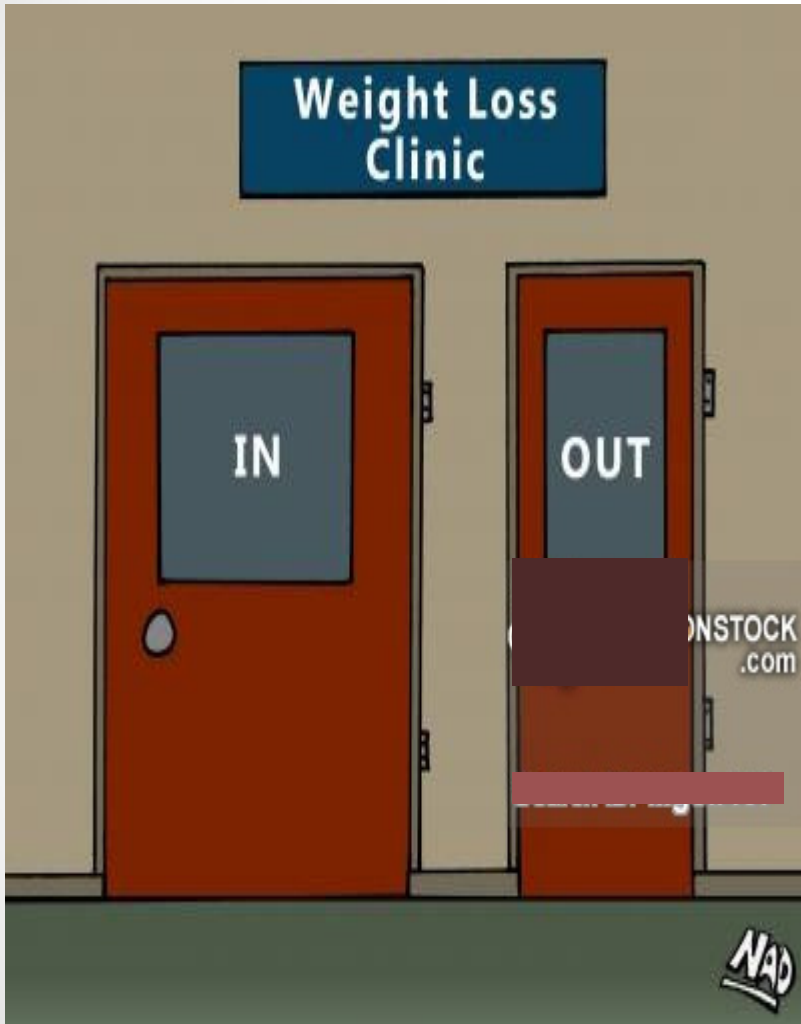
Documented failure of nonsurgical weight-loss programs

Psychologically stable with realistic expectations

Well-informed and motivated patient
Supportive family/social environment

Absence of uncontrolled psychotic or depressive disorder (eating disorders)

No active alcohol or substance abuse

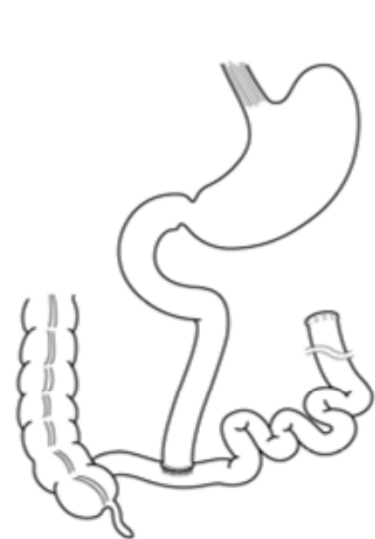


- Improved quality of life
- Decreased risk of death for morbidly obese people

Types of Bariatric Procedures

- Malabsorptive:
 - Jejuno-ileal bypass
 - Biliopancreatic Diversion
 - Duodenal Switch (DS), no bypass
- Restrictive:
 - Vertical sleeve gastrectomy**
 - Laparoscopic adjustable gastric banding**
- Restrictive and Malabsorptive:
 - Roux-en Y gastric bypass**
 - Distal gastric bypass with DS





Jejunioileal Bypass



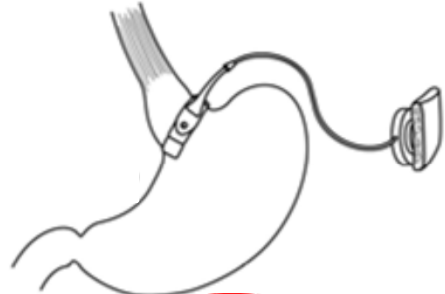
Biliopancreatic Diversion



Duodenal Switch



Vertical Banded Gastroplasty



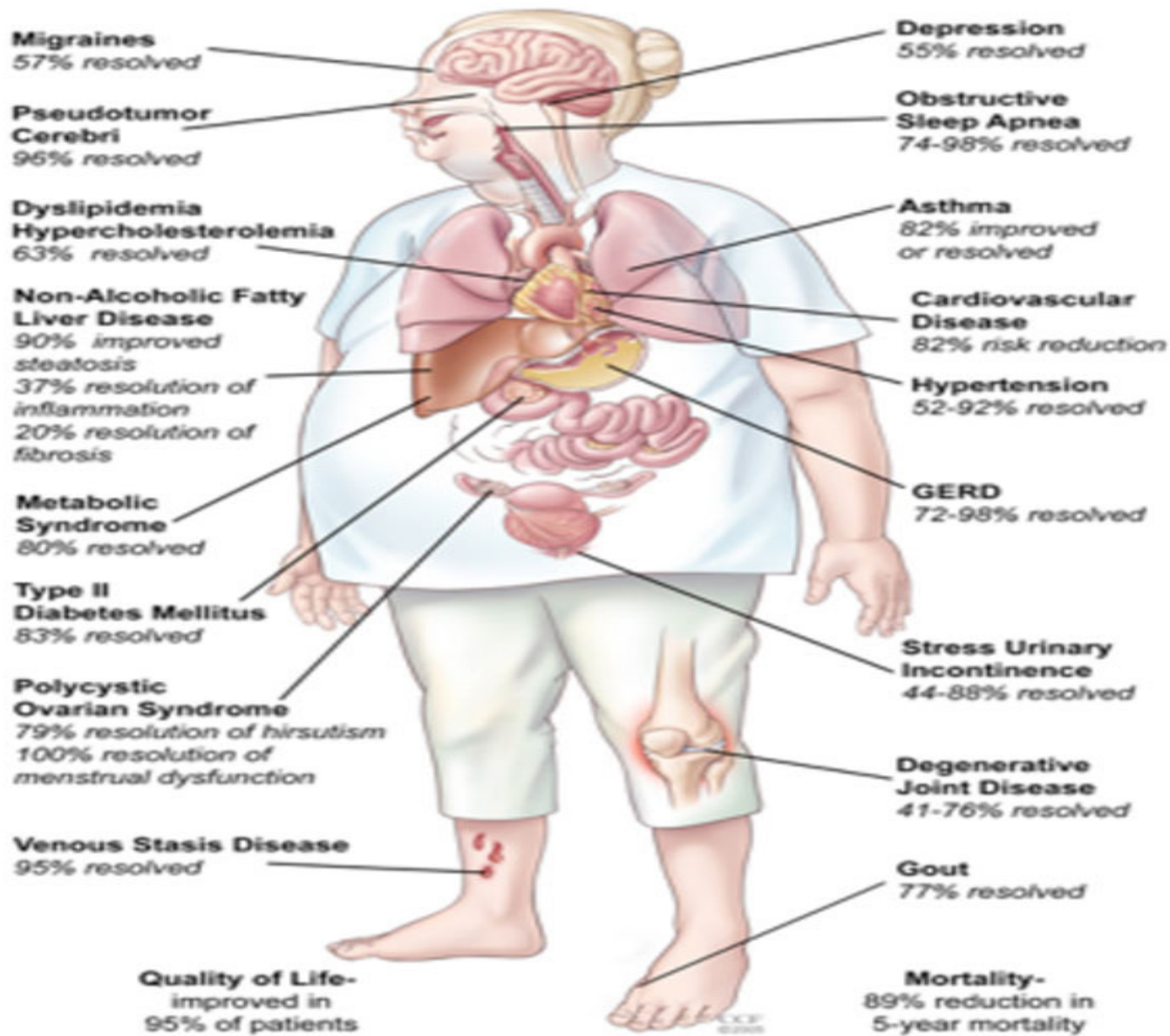
Adjustable Gastric Band



Roux-en-Y Gastric Bypass



Vertical Sleeve Gastrectomy



Nutrients deficiencies post bariatric surgery

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PARADOX!!!

- Micronutrient deficiencies may be higher in prevalence in overweight and obese adults and children, particularly in those suffering from extreme obesity
- Excess caloric intake but not necessarily adequate nutrients intake
- Increased adiposity itself may influence the serum levels of some fat soluble vitamins, such as vitamin D
- Iron deficiency, thiamine
- Correct vitamin/nutrient deficiencies before surgery
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After bariatric surgery

- Nutritional deficiencies of selected micronutrients and macronutrients after bariatric surgery has been recognized for decades
- Varies widely in prevalence and severity depending on type of bariatric surgery

Risk of Deficiencies

- Determined by the type of surgical intervention
 - Restrictive Minimal risk
 - Malabsorptive Moderate risk
 - Combination High risk

Mechanisms

- Bypassing a portion of the small intestine (JIB, BPD, BPD-DS, and RYGB) → greatest risk of nutritional deficiencies
- Proximal small intestine is the primary site of calcium, copper and iron absorption
- Risk of malabsorption and nutrient deficiencies increases proportionally with the length of bypassed proximal intestine



Mechanisms

- Gastric resection or bypass of the body of the stomach also reduces mechanical digestion and acid secretion
- Impairs digestion and absorption of iron, vitamin B12 and other protein-bound nutrients
- Diminishes secretion of intrinsic factor → impaired absorption of vitamin B12



Mechanisms

- Even purely restrictive procedures can lead to nutritional deficiencies resulting from restricted dietary intake, particularly within the first few months of surgeries, but also over long-term follow up
- Excessive postoperative nausea and vomiting, though rare, can also contribute to and exacerbate nutritional deficits in both restrictive and restrictive-malabsorptive procedures



Common Nutrient Deficiencies

- Gastric Bypass:
 - Most common: Iron, Vitamin B-12, Folic acid, Fat soluble Vitamins A, D, & E
 - Thiamin (seen in patients with frequent vomiting)
 - Calcium
 - Protein malnutrition
- Gastric Banding:
 - Nutrition deficiencies are less commonly seen post gastric banding
- Sleeve Gastrectomy
 - Possible B-12



Iron deficiency and anemia

- Most common and earliest nutritional deficiency
- Particularly after RYGB
- As high as 49% of patients
- Often asymptomatic, can lead to anemia and fatigue and in severe cases, can present with pica
- Multifactorial cause
 - Low gastric acid
 - Absorption inhibited (duodenum or proximal jejunum)
 - Decrease in iron-rich food consumption due to intolerance (red meat)

- For prevention 35-100 mg/d
- Mild cases will respond to oral supplementation, whereas more severe cases require intravenous replacement or even transfusions
- Menstruating women, pregnant women, and adolescents particularly predisposed
- Preoperative assessment of patients should include a complete hematological work-up, including measurement of iron stores



Vitamin D and Calcium Deficiency

- Vitamin D deficiency preoperatively is common among obese people
- Post operatively in 25-75%
- Vitamin D is required for Ca^{++} absorption
- Calcium absorption decreased because duodenum is bypassed
- Intolerance to dairy, foods high in calcium
- Prolonged deficiencies lead to
 - Bone resorption, osteomalacia, osteoporosis and secondary hyperparathyroidism, decreased bone mass as early as 3 to 9 months after surgery
 - Monitor BMD
- Calcium citrate (1500-1800 mg/d) and Vitamin D3 (1000-3000) IU/d depending on type
- Higher doses if deficiency

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Vitamin B12 deficiency

- More commonly associated with RYGB (up to one third of patients)
- 20 - 70% of patients
- Lack of hydrochloric acid and pepsin in stomach
 - Prevents B12 cleavage from food
 - Affects secretion of intrinsic factor, thus B12 absorption
- Intolerance to meat and milk
- Multivitamin supplementation alone not sufficient to prevent vitamin B12 deficiency
- Daily oral vitamin B12 of 500 µg as prophylaxis
- Intramuscular monthly vitamin B12 injections are another option
- Deficiency: IM injections of 1000µg weekly for 8 weeks



Folate Deficiency

- 40% of gastric bypass patients
- Complete absorption requires B12
- Absorption dependent on HCl and upper 1/3 stomach
- Deficiency generally caused by decreased consumption
- Special attention in pregnant women
- Oral supplementation 1 mg/d for prophylaxis and 5 mg/d for deficiency treatment



Thiamine deficiency

- Baseline B1 deficiency reported in up to 29% of patients
- More common after gastric bypass (decreased acidification of food and impaired absorption)
- Isolated cases reported after purely restrictive procedures
- Typically this occurs around 6 weeks to 3 months after surgery, but has been reported to occur as early as 2 weeks post-operatively
- Risk factors include excessive post-operative vomiting leading to reduced intake and non-adherence to multi-vitamin supplementation
- Wernicke's encephalopathy (ataxia, confusion, and blurred vision)
- Do not use dextrose-containing intravenous fluids as this may result in permanent neurological injury.
- Thiamine 100-500 mg IV then 50 mg daily



Other Nutrition Complications

- Vitamin A deficiency
- Vitamin C Deficiency
- Zinc deficiency
- Selenium deficiency
- Copper deficiency
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Screen after any bariatric procedure if suggestive symptoms

Copper	Serum copper	Anemia, neuropathy
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Zinc	Plasma zinc	Acrodermatitis enteropathica-like rash, taste alterations
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Additional annual screening after BPD and BPD-DS

Vitamin A	Plasma retinol	Reduced night vision, visual impairment
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Vitamin E	Plasma alpha-tocopherol	Neuropathy, ataxia
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Vitamin K	Prothrombin time	Bleeding, easy bruising
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Protein deficiency

- Reduced caloric intake (<1000 Kcal/d) especially during first six months → macronutrient deficiencies esp. protein
- Peak incidence – 1-2yr post op
- Advised intake 1 to 1.5 g of protein per kg of ideal body weight (a minimum of 60 g of protein per day)
- Purely restrictive procedures and RYGB with 75–150cm Roux limb lengths rarely cause hypoalbuminemia
- Increased risk with Longer Roux limb lengths in RYGB



- Mechanism:
 - ❖ 50% duodenal absorption
 - ❖ Intake def (intolerance to meat)
 - ❖ Decreased pancreatic enzyme secretion
 - ❖ Contact time↓

Protein deficiency

- Symptoms: asthenia, alopecia and hair loss, edema and contribute to poor wound-healing
- Significant protein-calorie malnutrition or kwashiorkor is rarely seen
- Milder cases may respond to increased oral protein intake. Severe cases may require total parenteral nutrition or surgical revision



Baseline, 3 months, 6 months and annual screening after bariatric surgery

Nutrient	Biomarker(s)	Primary symptoms of deficiency
Vitamin B ₁	Serum thiamin	Ophthalmoplegia, nystagmus, ataxia, encephalopathy, rapid visual loss (Wernicke encephalopathy) Isolated peripheral neuropathy
Vitamin B ₁₂	Serum vitamin B ₁₂	Anemia, neurological dysfunction, visual loss
Folate	Red blood cell folate Consider plasma homocysteine	Anemia
Iron	Serum, ferritin, total iron binding capacity, complete blood count with differential	Microcytic anemia
Vitamin D	Serum 25(OH) vitamin D, calcium, phosphorus, parathyroid hormone	Decreased bone mineral density Secondary hyperparathyroidism
Protein	Serum albumin	Edema, excessive alopecia, poor wound- healing

Pregnancy

- Pregnancy after bariatric surgery very safe after the rapid weight loss phase has ended and stable weight achieved
- Anemia most common complication (iron p.o., IV and transfusions)
- Nutrient deficiencies should be identified before and corrected prior to pregnancy
- Additional vitamin and calcium supplementation often necessary



Nutritional supplementation

- No standard regimen for nutritional supplementation after bariatric surgery
- Clinical practice guidelines for perioperative nutrition have been published jointly by the AACE, The Obesity Society (TOS), and the American Society for Metabolic and Bariatric Surgery (ASMBS).



- Gastric bypass and biliopancreatic diversion require more supplementation than non-bypass operations.
- Sleeve gastrectomy and adjustable gastric band patients may be maintained with minimal supplementation, such as a daily multivitamin with or without additional calcium.
- Supplementation regimens may be customised for each patient according to follow up labs

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Typical post-gastric bypass regimen would include:

- Multivitamin (Chewable)
- Calcium supplementation
- Iron supplementation
- Vitamin B12

General supplementation recommendations

Supplement	Daily Recommendations	
Multivitamin (contains folic acid)	AGB/VSG RYGB BPD-DS	One daily One to two daily Two daily
Calcium citrate with vitamin D ₃	AGB RYGB and BPD-DS	1200–1500mg/day 1800 mg/day
Vitamin D ₃	RYGB BPD-DS	1000- 3000 IU/d titrate to reach 25(OH)D > 30 ng/ml
Vitamin B ₁₂	RYGB BPD-DS	crystalline 500-1000 µg/day oral or 1000 µg/month intramuscularly monitor and start if needed.
Folic acid		400 µg/day as part of MVI
Elemental iron	RYGB and BDP-DS	45 - 60 mg elemental iron
Vitamin B ₁	All procedures	consider once daily in first 6 months
Vitamin A, K	BPD-DS	10,000 IU vitamin A and 300 µg/vitamin K

Hypoglycemia

- Noninsulinoma pancreatogenous hypoglycemia syndrome (NIPHS)
- Dumping syndrome
- Insulinoma
- Factitious or iatrogenic causes



Take Home

- Bariatric surgery can be life-saving for the right patient
- Awareness of pre-existing nutritional deficiencies in overweight and obese patients
- Recognize and treat both common and rare nutritional deficiencies that may arise or worsen following bariatric surgery
- Attention to adequate nutrition and vitamin supplementation
- Lifelong monitoring is essential





**THANK
YOU**