Metabolic Sequelae of Bariatric Surgery

Roula BOU KHALIL
Ass. Prof of Endocrinology
SGHUMC
Balamand University
OUTLINE

• Introduction
• Indications and metabolic benefits of bariatric surgery
• Obesity Paradox
• Micronutrients deficiencies
• Macronutrients deficiencies
• Pregnancy state
• Hypoglycemia post bariatric surgery
• Supplementation protocols
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.
<table>
<thead>
<tr>
<th>Candidates for bariatric surgery</th>
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<tbody>
<tr>
<td>Body mass index (BMI) $\geq 40$ kg/m² or BMI $\geq 35$ kg/m² with significant obesity-related co-morbidities</td>
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<td>Acceptable operative risk</td>
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<td>Documented failure of nonsurgical weight-loss programs</td>
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<td>Psychologically stable with realistic expectations</td>
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<td>Well-informed and motivated patient</td>
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<td>Supportive family/social environment</td>
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<td>Absence of uncontrolled psychotic or depressive disorder (eating disorders)</td>
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<td>No active alcohol or substance abuse</td>
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• 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
  - Laproscopic adjustable gastric banding

- Restrictive and Malabsorptive:
  - Roux-en Y gastric bypass
  - Distal gastric bypass with DS
Jejunoileal Bypass  Biliopancreatic Diversion  Duodenal Switch

Vertical Banded Gastroplasty  Adjustable Gastric Band  Roux-en-Y Gastric Bypass  Vertical Sleeve Gastrectomy
Migraines
57% resolved

Pseudotumor
Cerebri
96% resolved

Dyslipidemia
Hypercholesterolemia
63% resolved

Non-Alcoholic Fatty
Liver Disease
90% improved
steatosis
37% resolution of
inflammation
20% resolution of
fibrosis

Metabolic
Syndrome
80% resolved

Type II
Diabetes Mellitus
83% resolved

Polycystic
Ovarian Syndrome
79% resolution of hirsutism
100% resolution of
menstrual dysfunction

Venous Stasis Disease
95% resolved

Depression
55% resolved

Obstructive
Sleep Apnea
74-98% resolved

Asthma
82% improved
or resolved

Cardiovascular
Disease
82% risk reduction

Hypertension
52-92% resolved

GERD
72-98% resolved

Stress Urinary
Incontinence
44-88% resolved

Degenerative
Joint Disease
41-76% resolved

Gout
77% resolved

Quality of Life-
improved in
95% of patients

Mortality-
89% reduction in
5-year mortality
Nutrients deficiencies post bariatric surgery
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
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) \( \rightarrow \) 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
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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</thead>
<tbody>
<tr>
<td><strong>Copper</strong></td>
<td>Serum copper</td>
<td>Anemia, neuropathy</td>
</tr>
<tr>
<td><strong>Zinc</strong></td>
<td>Plasma zinc</td>
<td>Acrodermatitis enteropathica-like rash, taste alterations</td>
</tr>
<tr>
<td><strong>Vitamin A</strong></td>
<td>Plasma retinol</td>
<td>Reduced night vision, visual impairment</td>
</tr>
<tr>
<td><strong>Vitamin E</strong></td>
<td>Plasma alpha-tocopherol</td>
<td>Neuropathy, ataxia</td>
</tr>
<tr>
<td><strong>Vitamin K</strong></td>
<td>Prothrombin time</td>
<td>Bleeding, easy bruising</td>
</tr>
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*Screen after any bariatric procedure if suggestive symptoms*

*Additional annual screening after BPD and BPD-DS*
Protein deficiency

- Reduced caloric intake (<1000 Kcal/d) especially during first six months \(\Rightarrow\) 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

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Biomarker(s)</th>
<th>Primary symptoms of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Serum thiamin</td>
<td>Ophthalmoplegia, nystagmus, ataxia, encephalopathy, rapid visual loss (Wernicke encephalopathy) Isolated peripheral neuropathy</td>
</tr>
<tr>
<td>Vitamin B&lt;sub&gt;12&lt;/sub&gt;</td>
<td>Serum vitamin B&lt;sub&gt;12&lt;/sub&gt;</td>
<td>Anemia, neurological dysfunction, visual loss</td>
</tr>
<tr>
<td>Folate</td>
<td>Red blood cell folate</td>
<td>Anemia</td>
</tr>
<tr>
<td></td>
<td>Consider plasma homocysteine</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Serum, ferritin, total iron binding capacity, complete blood count with differential</td>
<td>Microcytic anemia</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Serum 25(OH) vitamin D, calcium, phosphorus, parathyroid hormone</td>
<td>Decreased bone mineral density Secondary hyperparathyroidism</td>
</tr>
<tr>
<td>Protein</td>
<td>Serum albumin</td>
<td>Edema, excessive alopecia, poor wound- healing</td>
</tr>
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</table>
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
Typical post-gastric bypass regimen would include:

- **Multivitamin** (Chewable)
- **Calcium supplementation**
- **Iron supplementation**
- **Vitamin B12**
### General supplementation recommendations

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Daily Recommendations</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivitamin (contains folic acid)</td>
<td>AGB/VSG</td>
<td>One daily</td>
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<tr>
<td></td>
<td>RYGB</td>
<td>One to two daily</td>
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<tr>
<td></td>
<td>BPD-DS</td>
<td>Two daily</td>
</tr>
<tr>
<td>Calcium citrate with vitamin D₃</td>
<td>AGB</td>
<td>1200–1500mg/day</td>
</tr>
<tr>
<td></td>
<td>RYGB and BPD-DS</td>
<td>1800 mg/day</td>
</tr>
<tr>
<td>Vitamin D₃</td>
<td>RYGB</td>
<td>1000- 3000 IU/d</td>
</tr>
<tr>
<td></td>
<td>BPD-DS</td>
<td>titrate to reach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25(OH)D &gt; 30 ng/ml</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>RYGB</td>
<td>crystalline 500-1000 μg/day oral</td>
</tr>
<tr>
<td></td>
<td>BPD-DS</td>
<td>or 1000 μg/month</td>
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<td></td>
<td></td>
<td>intramuscularly</td>
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<tr>
<td></td>
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<td>monitor and start if needed.</td>
</tr>
<tr>
<td>Folic acid</td>
<td></td>
<td>400 μg/day as part of MVI</td>
</tr>
<tr>
<td>Elemental iron</td>
<td>RYGB and BDP-DS</td>
<td>45 - 60 mg elemental iron</td>
</tr>
<tr>
<td>Vitamin B₁</td>
<td>All procedures</td>
<td>consider once daily in first 6 months</td>
</tr>
<tr>
<td>Vitamin A, K</td>
<td>BPD-DS</td>
<td>10,000 IU vitamin A and 300 μg/vitamin K</td>
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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