Bypassing more than the Stomach: Micronutrient Deficiencies after Bariatric Surgery

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Associate Professor of Medicine
Pulmonary & Critical Care Medicine
Medical College of Wisconsin
You are asked to see Mr. Jones to evaluate for poor appetite...

Mr. Jones is a 50-year old man with a history of diabetes and gastric bypass for morbid obesity. He is admitted to the hospital after having multiple falls, particularly at night.

He has a poor appetite and is only able to eat small meals before feeling “full.” He feels he “loses his balance” after getting up and walking a few steps.

Could micronutrient deficiencies be responsible for Mr. Jones’ symptoms?

What does his history of gastric bypass have to do with micronutrient deficiency?
Objectives for Discussion

(1) Review the epidemiology of obesity and indications for bariatric surgery.

(2) Classify common bariatric surgical procedures leading to micronutrient deficiencies.

(3) Describe the pathophysiology of micronutrient deficiencies after bariatric surgery.

(4) Characterize common micronutrient deficiencies after bariatric surgery.

(5) Discuss strategies to evaluate for and manage micronutrient deficiencies.
A Brief History of Obesity

20,000 BC
- The burden of disease was of pestilence and famine
- Excess fat considered nature’s outfit for survival
- Venus of Willendorf exemplifies esthetic value of obesity in Stone Age Europe

1000-10,000 BC
- Despite agriculture, food remained scarce and obesity was a virtue.
- Suggestion of obesity’s consequences
  → Hippocrates described fatigue related to obesity.
  → Socrates danced every morning to maintain lean figure.

1400-1900 AD
- Obese viewed in arts and literature as affluent, jolly, lovable, power, strength and good-natured (e.g. Dickens’ Joe the Fat Boy and US Presidents of late 19th and early 20th century).
- William Cullen’s description of gout, breathing difficulty and fatigue

1900-2000s
- 1905 Osler described obesity as “morally reprehensible and undesirable”
- Metropolitan Life Insurance Co reports excess weight causes health problems
- William Taft’s obesity took a toll on his time in office

## How is obesity classified?

### Quetelet Index

<table>
<thead>
<tr>
<th>Body mass index (kg/m²)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;18.49</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal weight</td>
</tr>
<tr>
<td>25-29.9</td>
<td>Overweight*</td>
</tr>
<tr>
<td>30-34.9</td>
<td>Class I obesity</td>
</tr>
<tr>
<td>35-39.9</td>
<td>Class II obesity</td>
</tr>
<tr>
<td>&gt;40</td>
<td>Class III obesity</td>
</tr>
<tr>
<td>&gt;50</td>
<td>Class IV obesity</td>
</tr>
</tbody>
</table>

*Defines obese for Asian population using WHO and NIH scale.*

Hurt RT, Frazier TH, McClave SA, Kaplan LM. JPEN 2011;35:4S-13S
Where are the obese?

http://www.cdc.gov/obesity/data/adult.html
Obesity and Race

http://www.cdc.gov/obesity/data/adult.html
A Growing Problem

Percentage Increase (Baseline 1986)

- bmi > 30
- bmi > 35
- bmi > 40
- bmi > 45
- bmi > 50

Challenges Posed by the Obese ICU Patient

Challenges
- Airway management
- Vascular access
- Special equipment
- Pharmacology
- Nutrition Support

Consequences
- More immobility
- Pulmonary Mechanics
- Cardiovascular
- Limited diagnostics and therapies

Why is Obesity a Problem?

BMI vs mortality

Age standardised mortality rate per 100,000 person years

[Graph showing BMI vs mortality with arrows pointing to different age groups and gender comparison]

Not Simply “eating too much”

Food intake

Obesogenic Environment
- Energy-dense foods
  - Reduced physical activity

CNS-endocrine
- Alteration in satiety signals

Genetic Factors
- Monogenic obesity
- Polygenic obesity

Expend Energy

Why do Ambulatory Treatments Fail?

• Primary care MD’s
  • Have limited clinical time
  • Decreased incentive
  • Negative perception of obese patients
  • Poor training in lifestyle counseling
  • Use one liners: “eat less, exercise more”

• Obese patients
  • Don’t perceive weight as unhealthy: “it’s cosmetic”
  • Want a quick fix for a chronic problem
Indications for Bariatric Surgery

- BMI > 40 kg/m² without co-morbid conditions

- BMI 35-40 kg/m² with ONE of:
  - HTN
  - Type 2 DM
  - Nonalcoholic fatty liver
  - Obstructive sleep apnea
  - Obesity-hypoventilation
  - Asthma
  - Impaired quality of life

The stomach’s reservoir capacity is reduced, thus restricting caloric intake (surgically-induced early satiety).

The small bowel is shortened, thus reducing nutrient absorption (surgically-induced malabsorption).

MALABSORPTIVE: jejunoileal bypass

- Ligament of Treitz
- Colon
- Bypassed small intestine
- Small intestine reattached near colon
RESTRICTIVE: Sleeve Gastrectomy
MIXED: Roux-en-Y

15 cc pouch

Roux limb (75–100 cm)

Saltzman E, Karl JP. Annu Rev Nutr 2013;33:183-203
MIXED: biliopancreatic diversion with duodenal switch
Bariatric Surgery Worldwide

# Bariatric Surgery in USA

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
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<tbody>
<tr>
<td>Total</td>
<td>158,000</td>
<td>173,000</td>
<td>179,000</td>
<td>193,000</td>
<td>196,000</td>
</tr>
<tr>
<td>RNY</td>
<td>36.7%</td>
<td>37.5%</td>
<td>34.2%</td>
<td>26.8%</td>
<td>23.1%</td>
</tr>
<tr>
<td>Band</td>
<td>35.4%</td>
<td>20.2%</td>
<td>14%</td>
<td>9.5%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Sleeve</td>
<td>17.8%</td>
<td>33%</td>
<td>42.1%</td>
<td>51.7%</td>
<td>53.8%</td>
</tr>
<tr>
<td>BPD/DS</td>
<td>0.9%</td>
<td>1%</td>
<td>1%</td>
<td>0.4%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers
Open versus Laparoscopic

Bariatric Surgery Outcomes

**Graph:**

- **D Body-Mass Index**

  - **Change from Baseline**
  - **Month**

  - **Sleeve gastrectomy**
    - P < 0.001
  - **Gastric bypass**
    - P < 0.001
  - **Medical therapy**
    - P = 0.006

Bariatric Surgery Outcomes

Bariatric Surgery Outcomes

At 3 Years

Physical Functioning

Role Limitations Due to Physical Health

Social Functioning

Emotional Well-Being

Bodily Pain

Energy/Fatigue

General Health

Role Limitations Due to Emotional Problems

Medical therapy
Sleeve gastrectomy
Gastric bypass

0 Poor health
100 Good health

## Bariatric Surgery Outcomes

<table>
<thead>
<tr>
<th>MEDICAL CONDITION</th>
<th>% RESOLVED</th>
</tr>
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<tbody>
<tr>
<td>Type 2 Diabetes</td>
<td>77</td>
</tr>
<tr>
<td>Hypertension</td>
<td>62</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>62</td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>84</td>
</tr>
</tbody>
</table>

Complications of Bariatric Surgery

30 DAYS

Ulcers
Leaks/Stenosis
Obstruction
Bleeding
Pulmonary
DVT/PE

30 DAYS

Ulcers
Leaks/Stenosis
Vomiting
Bleeding
Dumping
NUTRITIONAL
<table>
<thead>
<tr>
<th>DIET STAGE</th>
<th>BEGIN</th>
<th>FLUIDS/FOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>POD 1-2</td>
<td>Clear liquids</td>
</tr>
<tr>
<td>Stage II</td>
<td>POD 3 (discharge diet)</td>
<td>No sugar liquids Protein rich liquids Chewable MVI Chewable Ca-vitamin D</td>
</tr>
<tr>
<td>Stage III</td>
<td>POD 10-14</td>
<td>Increase clear liquids Soft protein sources</td>
</tr>
<tr>
<td>Stage III</td>
<td>4 weeks post-op</td>
<td>Advance diet as tolerated</td>
</tr>
<tr>
<td>Stage III</td>
<td>5 weeks post-op</td>
<td>Continue protein with fruit Salad as tolerated</td>
</tr>
<tr>
<td>Stage IV</td>
<td>As hunger increases</td>
<td>Healthy solid food Vitamin and mineral supplementation</td>
</tr>
</tbody>
</table>
Post-Bariatric Surgery Malnutrition

**Macronutrients**
- Protein-calorie deficiency

**Micronutrients**
- Vitamins and trace minerals
  - Trace minerals <0.01% body weight
    - Require 1-100 mg/day in adults
  - Vitamins are organic compounds essential for normal metabolism
Vitamins and trace minerals

Fat soluble vitamins (A, D, E, K)

Water soluble vitamins (B1, B9, B12)

Trace minerals (Fe, Zn, Cu)
## Recommendations for Supplementation

<table>
<thead>
<tr>
<th>SUPPLEMENT</th>
<th>DOSAGE</th>
</tr>
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<tbody>
<tr>
<td>Vitamin A</td>
<td>500 mcg</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>10 mg</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>90-120 mcg</td>
</tr>
<tr>
<td>Thiamin</td>
<td>1.2 mg</td>
</tr>
<tr>
<td>Folic acid</td>
<td>400 mcg</td>
</tr>
<tr>
<td>Biotin</td>
<td>30 mg</td>
</tr>
<tr>
<td>Selenium</td>
<td>55 mg</td>
</tr>
<tr>
<td>Zinc</td>
<td>8-11 mg</td>
</tr>
<tr>
<td>Copper</td>
<td>2 mg</td>
</tr>
<tr>
<td>Calcium citrate/carbonate (PO)</td>
<td>1200 -1500 mg/day</td>
</tr>
<tr>
<td>Vitamin D (PO)</td>
<td>800 units/day</td>
</tr>
<tr>
<td>Iron (PO)</td>
<td>40-65 mg elemental iron/day</td>
</tr>
<tr>
<td>Vitamin B12 (PO, SL, IN, or IM)</td>
<td>500-1000 mcg/day tablet/ 1000 mcg IM/month</td>
</tr>
</tbody>
</table>

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Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
What causes post-bariatric micronutrient deficiency?

1. Pre-bariatric surgery
   - Obesity (altered nutrient transporter)
   - Poor diet quality
   - Pre-operative weight loss

Saltzman E, Karl JP. Annu Rev Nutr 2013;33:183-203
## Specific pre-bariatric deficiencies

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Preoperative Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin</td>
<td>0-29%</td>
</tr>
<tr>
<td>Folate</td>
<td>3-4%</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>3-8%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>43%</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>17%</td>
</tr>
<tr>
<td><strong>Vitamin D</strong></td>
<td><strong>80-90%</strong></td>
</tr>
<tr>
<td>Vitamin E</td>
<td>0%</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>NA</td>
</tr>
<tr>
<td>Iron</td>
<td>26%</td>
</tr>
<tr>
<td>Zinc</td>
<td>14-30%</td>
</tr>
<tr>
<td>Selenium</td>
<td>58%</td>
</tr>
<tr>
<td>Copper</td>
<td>NA</td>
</tr>
</tbody>
</table>

What causes post-bariatric micronutrient deficiency?

2 Post-bariatric surgery

Nonadherence to diet/supplements
Alcohol or substance abuse
Reduced food quality/intake
Hormonal satiety
Reduced gastric acid secretion
Altered absorption
Nutrient Absorption in the GI Tract

- **Stomach**
  - Water
  - Ethyl Alcohol
  - Copper
  - Iodide
  - Fluoride
  - Molybdenum
  - Intrinsic Factor

- **Duodenum**
  - Calcium
  - Iron
  - Phosphorus
  - Magnesium
  - Copper
  - Thiamin
  - Riboflavin
  - Selenium
  - Niacin
  - Biotin
  - Folate
  - Vit A, D, E, K

- **Jejunum**
  - Thiamin
  - Riboflavin
  - Niacin
  - Pantothenate
  - Biotin
  - Folate
  - Pyridoxine
  - Vit C
  - Vit A, D, E, K
  - Selenium

- **Ileum**
  - Vit C
  - Folate
  - Vit B12
  - Vit D
  - Vit K
  - Selenium
  - Magnesium
  - Molybdenum
  - Amino acids

- **Colon**
  - SCFA
  - Water
  - Sodium
  - Zinc
  - Chromium
  - Manganese
  - Bile salts

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Post-Surgical Mechanisms for Micronutrient Deficiency

Reduced intake and gastric acid

Altered absorption

Peptide YY
CCK
GLP-1

Ghrelin
A 45-year old woman who was morbidly obese (BMI 45) underwent BPD with duodenal switch.

Two years after the procedure, her weight loss is sustained. She complains of non-specific joint pain, fatigue, bruises easily, and has had difficulty seeing at night.

Which micronutrient deficiency MOST LIKELY explains her symptoms?

[A] Thiamine
[B] Folate
[C] Iron
[D] Fat-soluble vitamins
[E] Copper
## CASE 1: Fat Soluble Vitamin Deficiencies

<table>
<thead>
<tr>
<th>VITAMINE</th>
<th>PRE-OP</th>
<th>POST-OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>17%</td>
<td>10-69%</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>80-90%</td>
<td>30-100%</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>0%</td>
<td>0-22%</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>NA</td>
<td>0-68%</td>
</tr>
</tbody>
</table>

Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
CASE 1: Fat Soluble Vitamin Deficiencies

Saltzman E, Karl JP. Annu Rev Nutr 2013;33:183-203
CASE 1: Fat Soluble Vitamin Deficiencies

<table>
<thead>
<tr>
<th>DISORDER</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low vitamin A</td>
<td>52%</td>
<td>58%</td>
<td>70%</td>
<td>69%</td>
</tr>
<tr>
<td>Low vitamin D</td>
<td>57%</td>
<td>55%</td>
<td>46%</td>
<td>63%</td>
</tr>
<tr>
<td>Low vitamin K</td>
<td>14%</td>
<td>21%</td>
<td>13%</td>
<td>68%</td>
</tr>
</tbody>
</table>

## CASE 1: FAT SOLUBLE VITAMIN DEFICIENCY

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Symptoms</th>
<th>Monitoring</th>
<th>Repletion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitamin A</strong></td>
<td>Acne, dry eyes, night blindness</td>
<td>Serum retinol level</td>
<td>Oral 5000-1000 IU/day</td>
</tr>
</tbody>
</table>

Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
CASE 2

A 25-year old morbidly obese woman undergoes Roux-en-Y procedure. She is taking a proton pump inhibitor for “acid reflux.”

She is inconsistent in taking supplements. One year later, she reports pain in both calves and falls at night. She is found to be anemic with an MCV of 105 fL.

Which micronutrient deficiency MOST LIKELY explains her findings?

[A] Iron  
[B] Vitamin C  
[C] Vitamin A  
[D] Vitamin B12  
[E] Zinc
CASE 2: VITAMIN B12 DEFICIENCY

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SG</th>
<th>LAGB</th>
<th>RYBG</th>
<th>BPD-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B12</td>
<td>18%</td>
<td>0-19%</td>
<td>33-58%</td>
<td>22%</td>
</tr>
</tbody>
</table>
Whole-body storage is greater of 2000 micrograms is greater than daily need of 2 micrograms/day → thus deficiency may take years

CASE 2: VITAMIN B12 DEFICIENCY

Stabler SP. N Engl J Med 2013;368:149-60
### CASE 2: NUTRITIONAL ANEMIAS

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SG</th>
<th>LAGB</th>
<th>RYBG</th>
<th>BPD-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B12</td>
<td>18%</td>
<td>0-19%</td>
<td>33-58%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
Nutrient Absorption in the GI Tract

- **Stomach**
  - Water
  - Ethyl Alcohol
  - Copper
  - Iodide
  - Fluoride
  - Molybdenum
  - Intrinsic Factor

- **Duodenum**
  - Calcium
  - Iron
  - Phosphorus
  - Magnesium
  - Copper
  - Thiamin
  - Riboflavin
  - Niacin
  - Selenium
  - Biotin
  - Folate
  - Vit A, D, E, K

- **Jejunum**
  - Thiamin
  - Riboflavin
  - Niacin
  - Pantothenate
  - Biotin
  - Folate
  - Pyridoxine
  - Vit C
  - Vit A, D, E, K
  - Selenium

- **Ileum**
  - Calcium
  - Phosphorus
  - Magnesium
  - Iron
  - Zinc
  - Chromium
  - Manganese
  - Molybdenum
  - Amino acids
  - Vit C
  - Folate
  - Vit B12
  - Vit D
  - Vit K
  - Selenium
  - Magnesium
  - Bile salts

- **Colon**
  - SCFA
  - Water
  - Sodium
  - Vit K
  - Other

Slide borrowed and modified with permission from Robert G. Martindale MD PhD
### CASE 2: NUTRITIONAL ANEMIAS

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SG</th>
<th>LAGB</th>
<th>RYBG</th>
<th>BPD-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B12</td>
<td>18%</td>
<td>0-19%</td>
<td>33-58%</td>
<td>22%</td>
</tr>
<tr>
<td>Iron</td>
<td>14%</td>
<td>0-32%</td>
<td>25-50%</td>
<td>21-26%</td>
</tr>
</tbody>
</table>

References:
- Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
CASE 2: NUTRITIONAL ANEMIAS

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>CBC CLUE*</th>
<th>TESTING</th>
<th>REPLETION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B12</td>
<td>Macrocytosis</td>
<td>B12, MMA</td>
<td>IV or PO</td>
</tr>
<tr>
<td>Folate</td>
<td>Macrocytosis</td>
<td>Folate</td>
<td>PO</td>
</tr>
<tr>
<td>Iron</td>
<td>Microcytosis</td>
<td>Ferritin</td>
<td>IV or PO</td>
</tr>
</tbody>
</table>

Macrocytosis is a large red blood cell, greater than 96 femtoliters \((10^{-15})\)
Microcytosis is a small red blood cell, less than 80 femtoliters

*Note: one MICROCYTIC and one MACROCYTIC anemia will produce a NORMOCYTIC anemia with MCV 80-96 femtoliters

A 55-year old obese with diabetes, hypertension, and alcohol abuse underwent gastric banding. He was nauseated and had daily vomiting.

Within two months after the procedure, he was progressively confused and wife noticed he was “walking funny.”

Which micronutrient deficiency MOST LIKELY explains her symptoms?

[A] Calcium 
[B] Thiamine 
[C] Iron 
[D] Fat-soluble vitamins 
[E] Zinc
CASE 3: THIAMIN DEFICIENCY

Thiamin deficiency may occur within 3 weeks post bariatric surgery.

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SG</th>
<th>LAGB</th>
<th>RYBG</th>
<th>BPD-DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin</td>
<td>0%</td>
<td>0%</td>
<td>12%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Absorbed: Duodenum and jejunum

Clinical Presentations:
- Acute deficiency → Wernicke’s encephalopathy
- Chronic deficiency → Beriberi (dry and wet forms)

Laboratory Evaluation:
- Not necessary but can check erythrocyte thiamine transketolase activity (ETKA)

Recommended intake and Management of Deficiency:
- Daily requirement of 1.1 to 1.2 mg per day
- IV thiamin 100 mg followed by 100 mg per day for 5 days and subsequent oral maintenance in deficiency

Mechanik JI, Kushner RF, Sugerman HJ et al. Surg for Obes Rel Dis 2008;4:S109-S184
A 40-year old morbidly obese woman undergoes BPD-DS procedure. She was given iron and zinc supplements.

She’s having tingling in both legs and reports falling. She’s found to have a microcytic anemia. Ferritin levels are normal.

Which micronutrient deficiency MOST LIKELY explains her findings?

[A] Folate
[B] Copper
[C] Thiamine
[D] Vitamin A
[E] Selenium
Absorbed: Stomach and proximal duodenum

Clinical Presentations:
- Fragile hair and depigmented skin
- Muscle weakness
- Neuropathy
- Ataxia

Laboratory Evaluation:
- Microcytic anemia
- Low serum copper (free < 1.6 or total < 10 micromol/L)

Recommended intake and Management of Deficiency:
- 900 mcg per day for adults
- IV or PO copper supplementation for deficiency
A 45-year old morbidly obese woman undergoes BPD-DS procedure. She’s had numerous complications include strictures, bowel obstruction, and frequent nausea with vomiting.

During a clinic visit, she is found to have easily pluckable hair and dermatitis. She reports poor taste.

Which micronutrient deficiency MOST LIKELY explains her findings?

[A] Vitamin C
[B] Copper
[C] Iron
[D] Vitamin B12
[E] Zinc
Absorbed: Duodenum and jejunum

Clinical Presentations:
- Abnormal taste
- Skin changes
- Dry brittle hair
- Impotence
- Poor wound healing

Laboratory Evaluation: Serum levels are not useful

Recommended intake and Management of Deficiency:
- Daily requirement of 8 mg per day
- Aggressive supplementation can induce copper deficiency

OTHER MICRONUTRIENT DEFICIENCIES

- Selenium
- Vitamin B2
- Vitamin B3
- Vitamin B5
- Vitamin B7
- Vitamin C

Case reports of cardiac disease and muscle disease
1. Obesity is a national epidemic (marked increase in class IV obesity).

2. Bariatric surgery is the only proven method for sustained weight loss.

3. Bariatric procedures are classified restrictive, malabsorptive, or mixed.

4. Sleeve gastrectomy has over-taken Roux-en-Y as the most common procedure performed in the United States.
4. Micronutrient deficiencies are highly prevalent post-bariatric surgery due to pre-surgical post-surgical factors.

5. The most common pre-surgical micronutrient deficiency is vitamin D deficiency.

6. Post-surgical deficiencies depend on the type of surgery and associated complications.

7. The most common deficiencies include fat-soluble vitamins, vitamin B12, iron, thiamin, copper, and zinc.

8. Consider vitamin B12, folate, iron, and copper in evaluating post-bariatric surgery anemia.
Thank you