



Nutritional Deficiencies after Weight Loss Surgery



Maria Tucker, MPH, RD, LDN, CDE
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Duke Weight Loss Surgery



Objectives:

- Identify most common postoperative nutritional deficiencies by surgery type
- Identify signs and symptoms of nutritional deficiencies
- Management of nutritional deficiencies



What is Nutritional Deficiency?

Types of Nutritional Deficiencies:

- **Macronutrient deficiencies**
 - Carbohydrates
 - Protein
 - Fat
- **Micronutrient deficiencies**
 - Vitamins
 - Minerals



Nutritional Deficiency Risk by Surgery Type

Surgery Type	Vitamins at Risk	Minerals at Risk
RYGBP	Vitamin B12 Vitamin D Folate Thiamin	Calcium Iron
Vertical Sleeve Gastrectomy	Vitamin B12 Thiamin	Calcium Iron
BPD/Duodenal Switch	Vitamin A Vitamin D Vitamin K	Calcium Iron Zinc
Adjustable Gastric Banding	Vitamin B12 Folate Thiamin	



Pre-WLS Nutrition Screenings

Nutrient	Recommendation	Pre-WLS Prevalence of Deficiency
Thiamin (Vitamin B1)	Routine for all patients	16-29% reported
Cyanocobalamin (Vitamin B12)	Routine for all patients	2-18% in the obese 6-30% in those on PPI
Folate (Folic Acid)	Routine for all patients	Up to 54% in the obese
Iron	Routine for all patients	Up to 45% in the obese
Vitamin D	Routine for all patients	Up to 90% in the obese
Calcium	Routine for all patients	5-20 µg/mL
Fat-soluble Vitamins (A, E, K)	Routine for all patients	14% for vitamin A and 2.2% for vitamin E
Zinc	Routine for RYGBP and BPD-DS	24-28% in WLS patients 74% in those seeking BPD/DS
Copper	Routine for RYGBP and BPD/DS	Up to 70% in pre-BPD women



THIAMIN (VITAMIN B1)

- Post-WLS prevalence of deficiency - <1-49%
- Post-WLS screening recommended for patients with:
 - Rapid weight loss
 - Protracted vomiting
 - Parenteral nutrition
 - Excess alcohol use/alcoholism
 - Neuropathy/encephalopathy/heart failure
 - Malnourished patients
 - Female patients
 - African American and Hispanic patients
 - Patients with GI symptoms



THIAMIN (VITAMIN B1)

- Post-WLS supplementation for preventing deficiency:
 - At least 12 mg thiamin daily
and
 - Preferably 50 mg dose of thiamin from a B-complex supplement or multivitamin once or twice a day
- Post WLS supplementation for repletion:
 - Oral therapy: 100 mg 2-3x/day until symptoms resolve
 - IV therapy: 200 mg TID to 500 mg once daily or BID for 3-5 days, then 250 mg/day for 3-5 days or until symptoms resolve.
 - Should consider treatment with 100 mg/day orally
 - IM repletion: 250 mg once/day for 3-5 days or 100-250 mg monthly



Vitamin B12 (Cyanocobalamin)

- Post WLS prevalence of deficiency at 2-5 years:
 - <20% in RYGB and 4-20% in SG
- Post WLS screening recommended for RYGB, SG and BPD/DS
 - Every 3 months in the first post-WLS year
 - At least annually or as clinically indicated
- Include serum MMA with or without homocysteine:
 - in symptomatic and asymptomatic patients
 - in patients with h/o B12 deficiency or preexisting neuropathy



Vitamin B12 (Cyanocobalamin)

- Post WLS supplementation for preventing deficiency:
 - All post-WLS patients
 - Orally – 350-500 mcg daily
 - Nasal spray – as directed by manufacturer
 - Parenteral – 1000 mcg monthly
- Post-WLS supplementation for repletion:
 - 1000 mcg per day to achieve normal levels
 - Resume dosing recommended for preventing deficiency once normal levels reached



Folate (Folic Acid)

- Post-WLS prevalence of deficiency:
 - Reported in up to 65% of patients
- Post-WLS screening is recommended for all patients
 - Monitor post-WLS female child bearing age patients
- Post-WLS supplementation for preventing deficiency:
 - 400-800 mcg orally from multivitamin
 - 800-1000mcg orally for child bearing age women
- Post-WLS supplementation for repletion:
 - 1000 mcg daily to achieve normal levels, then resume dosage to maintain normal levels
 - Supplementation of 1 mg per day not recommended



Iron

- Post WLS prevalence of deficiency:
 - Reported to occur in post-WLS patients from 3 months to 10 years:
 - AGB – 14% SG - <18% RYGB – 20-55%
 - BPD – 13-62% DS – 8-50%
- Post WLS screening is recommended for all patients
 - Within 3 months post surgery
 - Every 3-6 months until 12-month visit
 - Annually after first year
 - Monitor iron status including iron panel, CBC, TIBC, ferritin, soluble transferrin receptor (if available)
 - Additional iron screening based on clinical s/s and/or lab findings or if deficiency is suspected



Iron

- Post-WLS supplementation to prevent deficiency:
 - Low risk patients: at least 18 mg from multivitamin
 - Menstruating women post RYGB, SG or BDP/DS:
 - 45-60 mg elemental iron total from all supplements
 - Iron should be taken separate from calcium supplements, acid-reducing medications and foods high phytates, polyphenols or tannins
- Post-WLS supplementation for repletion:
 - 150-200 mg of elemental iron daily up to 300 mg 2-3 times daily
 - Intravenous iron infusion may be needed if deficiency does not respond to oral iron therapy



Vitamin D and Calcium

- Post-WLS prevalence of deficiency:
 - Reported in up to 100% of post-WLS patients
 - More pronounced in RYGB and BPD/DS
- Post-WLS screening is recommended for all patients
 - 25(OH)D is preferred assay
 - DXA and PTH important to interpret vitamin D and calcium levels and detect later-developing deficiencies



Vitamin D and Calcium

- Post-WLS supplementation to prevent deficiency:
 - Preventative dosing of vitamin D is based on serum vitamin D levels:
 - 3,000 IU/day until blood levels of 25(OH)D is greater than sufficient
 - Calcium supplementation recommended for all post-WLS patients
 - Dosing by surgical procedure:
 - LAGB/SG/RYGB – 1200-1500 mg/day
 - BPD/DS – 1800-2400 mg/day



Vitamin D and Calcium

- Dosing considerations for enhancing calcium absorption:
 - Take calcium in divided doses
 - Calcium carbonate should be taken with meals
 - Calcium citrate may be taken without regard to food
- Post-WLS supplementation for vitamin D repletion:
 - 2000-6000 IU vitamin D3
 - 50000 IU vitamin D2 one to three times/week
- Post-WLS supplementation for calcium repletion:
 - LAGB/SG/RYGB: 1200-1500 mg/day
 - BPD/DS: 1800-2400 mg/day



Vitamins A, E and K

- Post-WLS prevalence of Vitamin A deficiency:
 - Up to 70% within 4 years post surgery
 - Associated with low prealbumin
 - Should be suspected in those with protein-calorie malnutrition
- Post-WLS screening is recommended within first year post-WLS, especially for BDP/DS



Vitamins A, E and K

- Post-WLS prevalence of Vitamin E and vitamin K deficiency:
 - Low prevalence of vitamin E deficiency post-WLS
 - Vitamin E levels may increase after RNYGB and BPD/DS
 - Complications related to vitamin K deficiency are rare



Vitamins A, E and K

- Post-WLS screening for vitamin E and K:
 - Insufficient evidence to support routine screening
 - Symptomatic patients should be screened
 - Low prothrombin time used as indicator of vitamin K deficiency
 - Mean prothrombin time found to be lower in RNYGB patients
- Post-WLS supplementation to prevent deficiency:
 - LAGB/SG and RYGB: fat-soluble vitamins in multivitamins
 - BPD/DS: additional 10000 IU/day vitamin A
300 mcg/day vitamin K



Vitamins A, E and K

- Post-WLS supplementation for repletion – Vitamin A:
 - Without corneal changes:
 - 10,000-25,000 IU/day vitamin A until clinically improved
 - With corneal changes 50000-100000 IU/day
 - Given IM x 3 days, then 50000 IU/day IM x 2 weeks
 - Consider evaluating for iron and/or copper deficiencies
- Post-WLS supplementation for repletion of vitamin E:
 - Optimal therapeutic dose post-WLS not clearly defined



Vitamins A, E and K

- Post-WLS supplementation for repletion of vitamin K:
 - with acute malabsorption
 - 10 mg parenteral dose of vitamin K
 - with chronic malabsorption
 - 1-2 mg/day orally or 1-2 mg/wk parenterally



Zinc

- Post-WLS screening for zinc deficiency:
 - Annual screening for RYGB or BPD/DS
 - Serum or plasma zinc appropriate for screening
 - Should be evaluated when iron deficiency anemia screening results are negative
 - Should be evaluated in patients with chronic diarrhea



Zinc

- Post-WLS supplementation to prevent deficiency:
 - Based on procedure type:
 - SG/LAGB – 100% RDA in multivitamins with minerals
 - RYGB – 100-200% RDA in multivitamins with minerals
 - BPD/DS – 200% RDA in multivitamins with minerals
 - Zinc to copper ratio:
 - 8-15 mg zinc per 1 mg copper



Zinc

- Post-WLS supplementation for repletion:
 - Previous recommendation:
 - 60 mg elemental zinc BID
 - Insufficient data to specify new dose recommendation
 - Careful selection of dose for zinc repletion is needed to prevent copper deficiency
 - Routine monitoring of zinc status through treatment course recommended



Copper

- Post-WLS screening for copper deficiency:
 - Routine screening recommended annually after RYGB or BDP/DS
 - Serum copper and ceruloplasmin are recommended biomarkers for copper status
- Post-WLS supplementation to prevent deficiency:
 - Based on procedure type:
 - SG or LAGB: 100% of RDA (1 mg/day)
 - RYGB or BPD/DS: 200% of RDA (2 mg/day)
 - Zinc to copper ratio: 1mg copper per 8-15 mg zinc



Copper

- Post-WLS supplementation for repletion:
 - Varies by severity of deficiency state
 - Mild to moderate deficiency – 3-8 mg/day oral copper gluconate or sulfate until normal level attained
 - Severe deficiency – 2-4 mg/day IV copper x 6 days or until normal level attained and neurological symptoms resolve
 - Once normal copper levels return, monitor copper levels every 3 months



Postoperative Vitamin Deficiencies

Vitamin	Normal Range	Postoperative Deficiency
B1 (thiamin)	2.5-7.5 µg/dL	<1-49%, varies based on procedure type, post op time frame and risk factors
Vitamin A	20-80 µg/dL	Up to 70% in RYGB and BPD/DS within 4 years
B12 (cyanocobalamin)	200-1,000 pg/mL	<20% in RYGB and 4-20% in SG post-WLS at 2-5 years
Folate (Folic Acid)	340-1020ng/mL	Reported in 65% of patients
Vitamin D	>30 ng/mL	Up to 100% of patients
Vitamin E	5-20 µg/mL	Uncommon
Vitamin K	PT: 10-13 seconds	Uncommon after WLS



Post-WLS Mineral Deficiencies

Minerals	Normal Range	Postoperative Deficiency
Iron	15-200 ng/mL (males) 12-150 ng/mL (females)	14% in LAGB <18% in SG 20-55% in RYGB 13-62% in BPD 8-50% in DS
Zinc	60-130 µg/dL	34% in LAGB 19% in post-SG 40% in post-RYGB Up to 70% in post-BPD/DS
Copper	Copper: 11.8-22.8 mmol/L Ceruloplasmin: 75-145 µg/dL	10-20% post-RYGB Up to 90% post-BDP/DS



Management of Nutritional Deficiencies

- **Vitamin B1 (thiamin)**

- **Early signs and symptoms:**

- Dry beriberi – peripheral neuropathy and/or polyneuritis, muscle weakness and/or pain of extremities, gait ataxia, convulsions
- Wet beriberi – heart failure, lower extremity edema, respiratory distress, lactic acidosis

- **Advanced signs and symptoms:**

- Wernicke's encephalopathy
- Korsakoff psychosis and/or Wernicke-Korsakoff syndrome

- **Diagnosis:**

- Favorable response to thiamin

- **Food Sources of Vitamin B1:**

- Fortified breakfast cereals, enriched rice, egg noodles, pork



Management of Nutritional Deficiencies

- **Vitamin B12 (cyanocobalamin)**

- **Early signs and symptoms:**

- Pernicious anemia/megaloblastic anemia
- Glossitis, fatigue, anorexia, diarrhea, pale
- Numbness and paresthesia in extremities, ataxia
- Lightheadedness or vertigo, shortness of breath
- Tinnitus, palpitations, rapid pulse

- **Advanced signs and symptoms:**

- Angina or symptoms of congestive heart failure
- Altered mental status



Management of Nutritional Deficiencies

- **Vitamin B12 (cyanocobalamin)**

- **Diagnosis:**

- CBC and vitamin B12 and folate levels
- Sometimes methylmalonic acid (MMA) levels or Schilling test

- **Food Sources of Vitamin B12:**

- Animal products, fortified cereal, some nutritional yeast products



Management of Nutritional Deficiencies

- **Vitamin A**

- **Early signs and symptoms:**

- Nyctalopia, Bitot's spots, endophthalmitis, poor wound healing
- Hyperkeratinization of the skin, loss of taste

- **Advanced signs and symptoms:**

- Corneal damage, xerosis, keratomalacia, perforation
- blindness



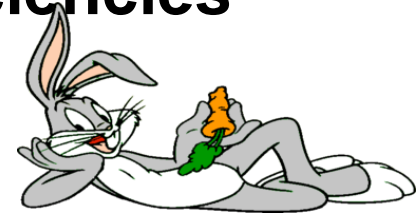


Management of Nutritional Deficiencies

- **Vitamin A**

- **Diagnosis:**

- Plasma retinol (normal range: 20-80 $\mu\text{g}/\text{dL}$)



- **Food Sources of Vitamin A:**

- Sweet potato, beef liver, spinach, carrots, sweet peppers, mangoes, black-eyed peas, dried apricots, ricotta cheese, tomato juice, herring, fortified ready to eat cereal, fortified skim milk, baked beans, eggs



Management of Nutritional Deficiencies



- **Vitamin D**

- **Symptoms:**

- Hypocalcemia, tetany, tingling, cramping
- Metabolic bone disease, rachitic tetany

- **Diagnosis:**

- Levels of 25(OH)D (D2 + D3)
- Diagnosis may be suspected based on:
 - Hx of inadequate sunlight exposure or dietary intake
 - Symptoms and signs of rickets, osteomalacia
 - Characteristic bone changes seen on x-ray

- **Food Sources of Vitamin D:**

- Cod liver oil, swordfish, salmon, tuna, fortified dairy and other products



Management of Nutritional Deficiencies

- **Vitamin K**

- **Symptoms:**

- Hemorrhage due to deficiency of prothrombin and other factors
- Easy bruisability and mucosal bleeding, delayed blood clotting, heavy menses, nose bleeding

- **Diagnosis:**

- Usually prolonged PT or elevated INR that decreases after phytonadione

- **Food Sources of Vitamin K:**

- Collards, turnip greens, spinach, kale, broccoli, soybeans, carrot juice





Management of Nutritional Deficiencies

- **Calcium**

- **Symptoms:**

- Hypocalcemia, muscle weakness and leg cramps, tetany, neuromuscular hyper-excitability, osteoporosis

- **Diagnosis:**

- Estimation or measurement of ionized Ca
 - Sometimes further testing with Mg, PTH, PO₄, alkaline phosphatase, and vitamin D concentrations in blood and cAMP and PO₄ concentrations in urine

- **Food Sources of Calcium:**

- Dairy products, Chinese cabbage, kale, broccoli, fortified products



Management of Nutritional Deficiencies

- **Iron**

- **Symptoms:**

- Fatigue, decreased work performance, impaired learning ability, microcytic anemia, decreased immune function, enteropathy, glossitis, dysphagia, koilonychias, vertical ridges on nails, rapid heart rate/palpitations

- **Diagnosis:**

- CBC, serum iron, iron-binding capacity, and serum ferritin

- **Food Sources of iron:**

- Fortified breakfast cereals and other products, meat, seafood, poultry, tofu, white beans, lentils, spinach





Management of Nutritional Deficiencies

- **Zinc**
 - **Early Symptoms:**
 - Rash, acne
 - Change in or absence of taste
 - Immune deficiency
 - Infertility
 - **Diagnosis:**
 - Plasma zinc
 - **Food Sources of zinc:**
 - Red meat, crab, lobster, poultry, fortified breakfast cereals and whole grains, beans, nuts, dairy products



Vitamin and Mineral Supplementation

Surgery Type	Start After Discharge from Hospital	Start 2-3 Weeks after Surgery
RYGB SG	Multivitamins: chewable or liquid which contain: 400mcg folic acid 15mg zinc 18mg iron Take 200% of the daily value.	Calcium Citrate: chewable and should contain Vitamin D ₃ 500-600 mg. 2-3 times a day Total: 1,200 – 1,500 mg /day Vitamin B-12: sublingual daily, nasal spray weekly or injection monthly 350 – 500 µg/day or 1,000 µg/month
BPD/DS	Multivitamins: chewable or liquid which contain: 400µg folic acid 15mg zinc 18mg iron Take 200% of the daily value.	Calcium Citrate: chewable and should contain Vitamin D ₃ 500-600 mg. 3-4 times a day Total: 1,800 – 2,400 mg /day Vitamin A, D, & K: water soluble or dry form Vitamin A: 10,000 IU Vitamin D: 3,000 IU Vitamin K: 300 µg May take these individually or use a multivitamin high in Vitamins A, D, & K.



Vitamin and Mineral Supplementation

Surgery Type	Start After Discharge from Hospital	Start 2-3 Weeks after Surgery
AGB	Multivitamins: chewable or liquid which contain: 400µg folic acid 15mg zinc 18mg iron Take 100% of daily value	Calcium Citrate: chewable or petite tablets 500-600 mg 2-3 times a day Total 1500 mg /day

Additional Supplements

Iron

Patients with a history of anemia and menstruating women may need to take an additional 45-60 mg of elemental iron daily.

Biotin

At least 3000 µg of biotin, usually marketed as hair, skin and nail vitamins, may be helpful in minimizing hair shedding after surgery.



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Thank You *Mahalo*
Tack **Kiitos**
Grazie **T** *Toda*
Obrigado **hanks**
Takk **Merci**
Gracias