



Gastrointestinal and Nutritional Complications of Bariatric Surgery

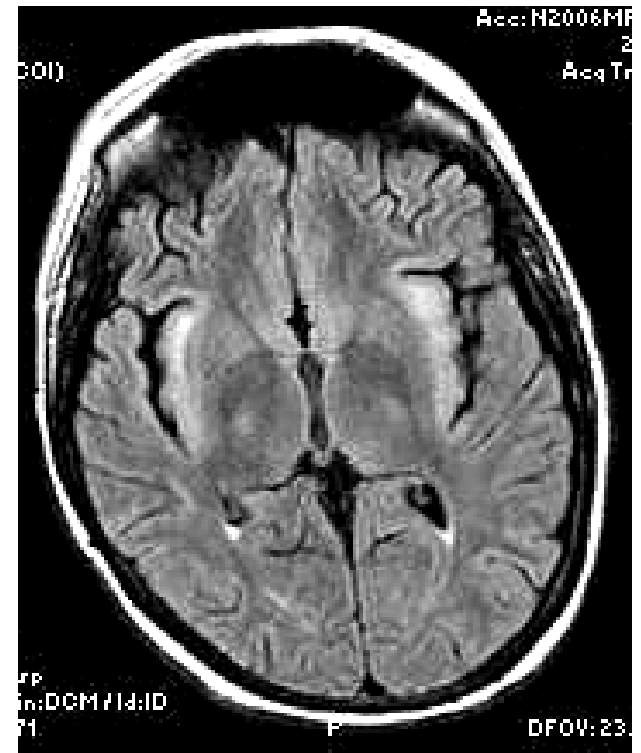
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2011

Case Presentation

- A 24 year old white female presents in a coma, one year after gastric bypass surgery.
- She was non-verbal, made no spontaneous movements, and was ventilator dependent but required no sedation.
- Her post-operative course had been complicated by nausea and vomiting.
- She had recently developed a peripheral neuropathy and was undergoing treatment for Guillain Barré syndrome.



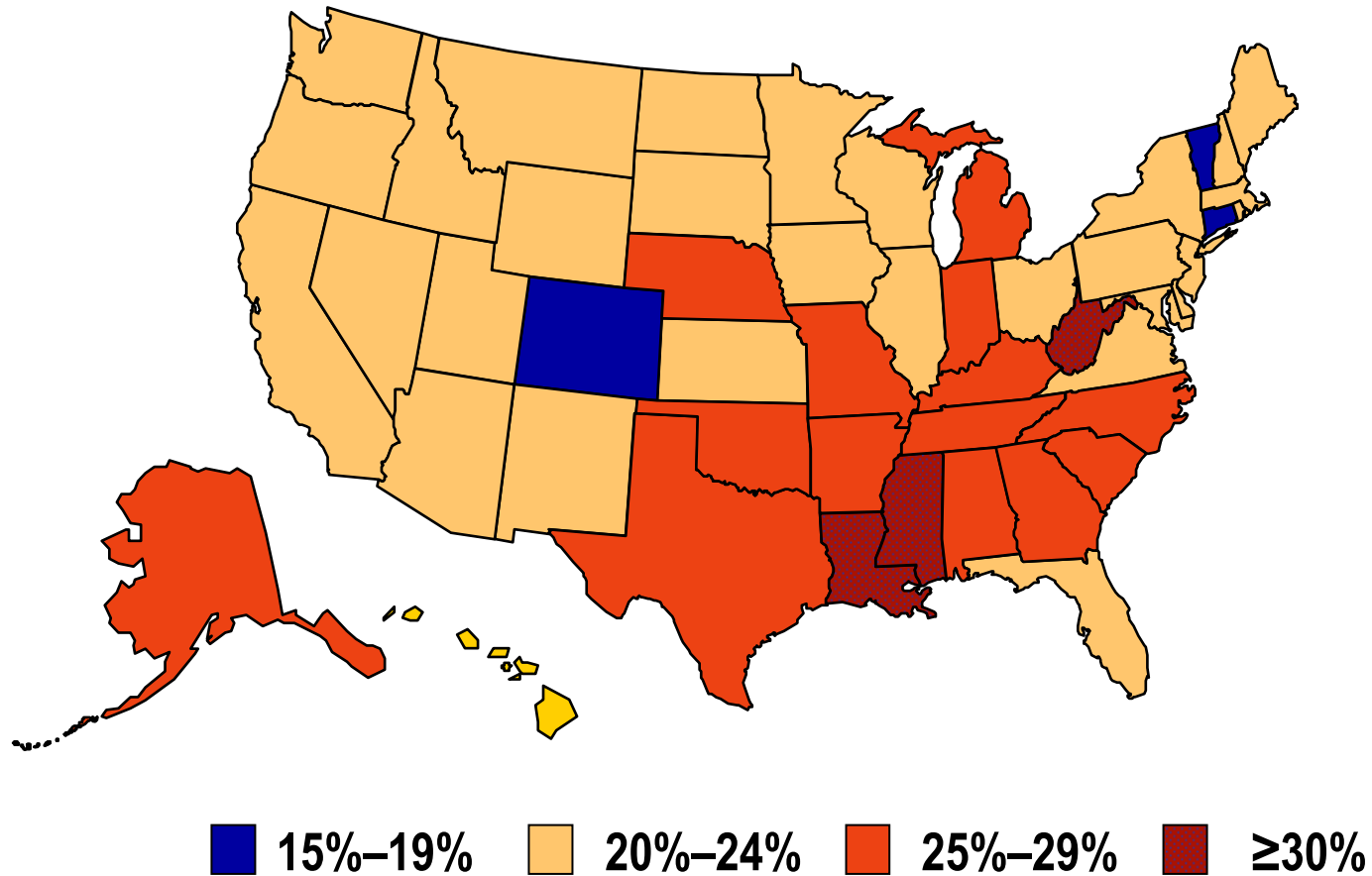
Bariatric Surgery Goals

- GI Complications
- Nutritional Complications
- Role of the internist



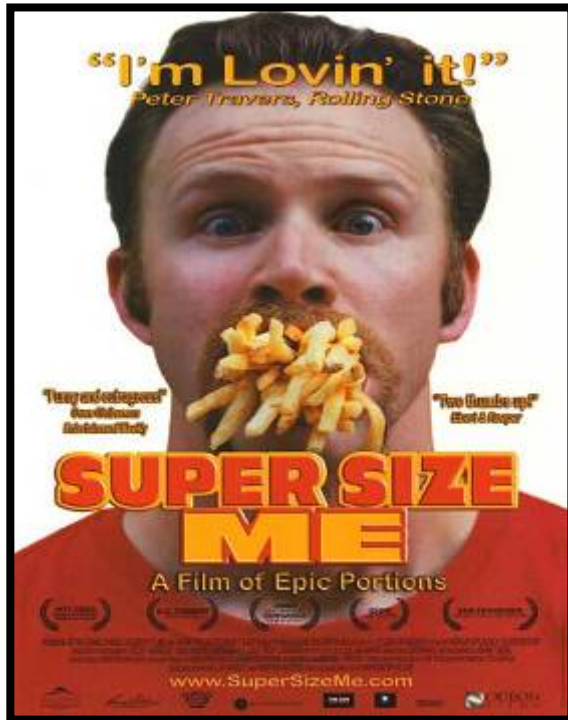
Obesity Trends U.S. Adults 2005

(*BMI ≥ 30 , or ~ 30 lbs overweight for 5' 4" person)



Source: Behavioral Risk Factor Surveillance System, CDC.

Diet and Exercise



Bariatric Surgery



- Members: 258 in 1998; 2929 in 2007.
- Procedures: 16,000 in 1990; 200,000 in 2006.
- Indications: BMI > 40.
BMI > 35 with comorbidities.

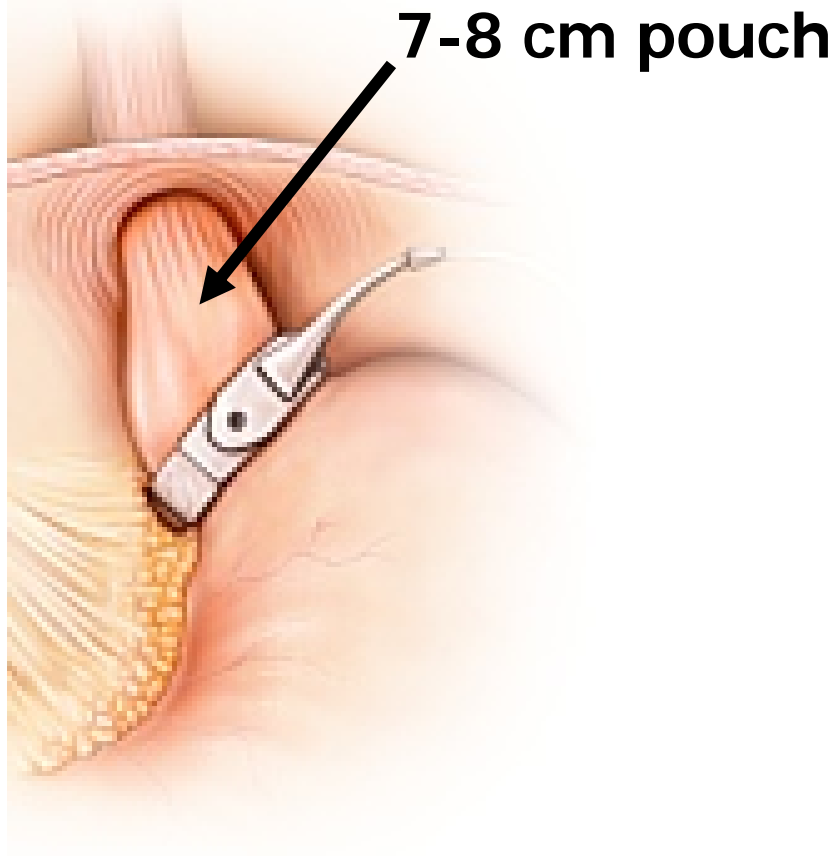


Centers of Excellence



- Ashland: Kings Daughters Medical Center
- Florence: St. Luke Hospital
- Georgetown: Georgetown Community Hospital
- Lexington: Saint Joseph East
- Louisville: Norton Hospital
 Sts. Mary and Elizabeth Hospital
- Bariatric patients admitted to other hospitals with complications will not be at a center for excellence.
- Hospitalists and medical consultants will provide the majority of their care.

Laparoscopic Adjustable Gastric Band



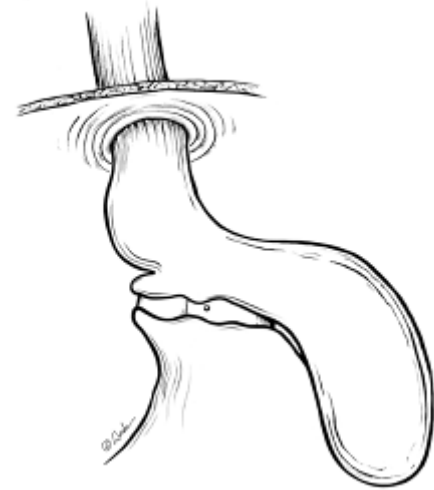
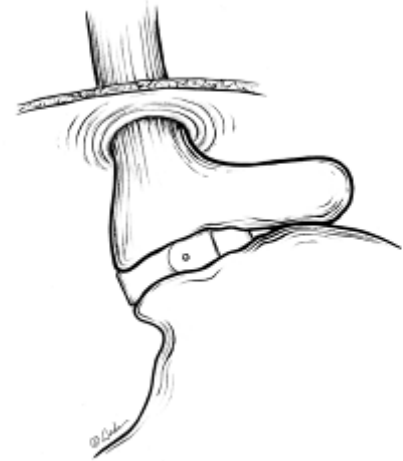


GI Complications – Lap Band

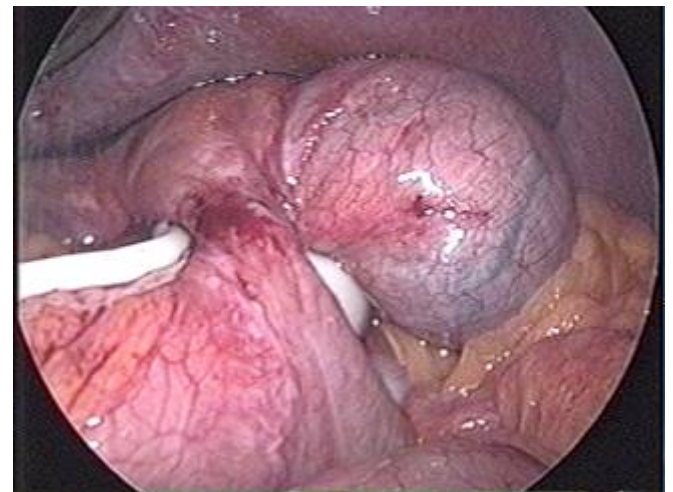
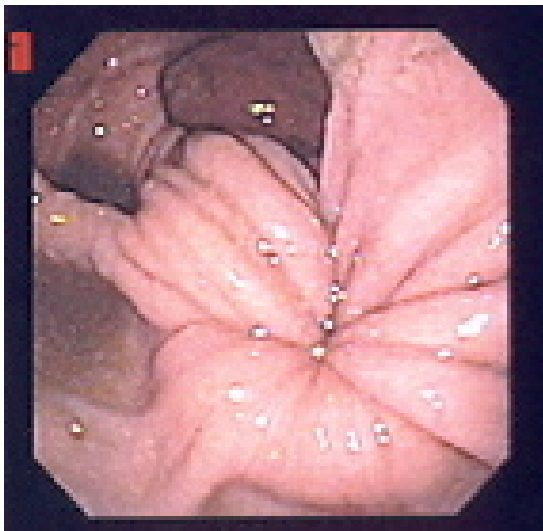
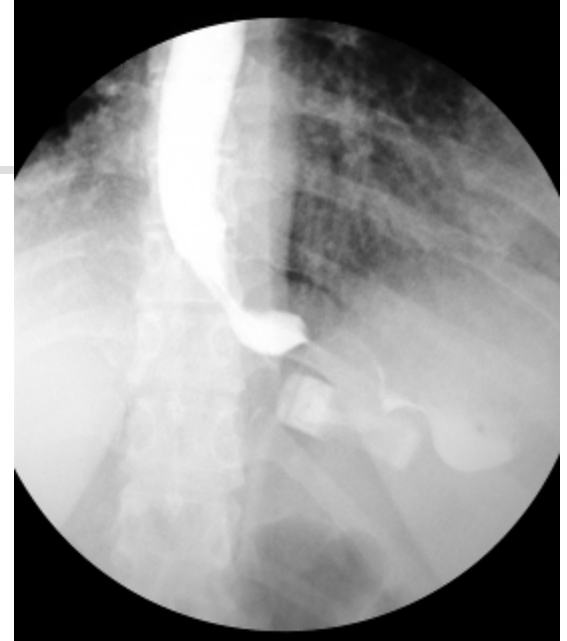
- Overall 10% complication rate.
- Symptoms: GERD, abdominal pain, nausea, vomiting, increased appetite, weight gain.
- Gastric Prolapse: 2%-4%.
- Band Erosion: < 2%.
- Obstruction / Esophageal Dilation: <1%.
- Port Problems

Gastric Prolapse

- Symptoms
 - Heartburn
 - Intolerance of solids, liquids
 - Nausea
 - Vomiting
 - Abdominal, back, shoulder pain
- Diagnosis
 - History
 - Plain radiographs
 - Contrast esophagram
 - Upper endoscopy

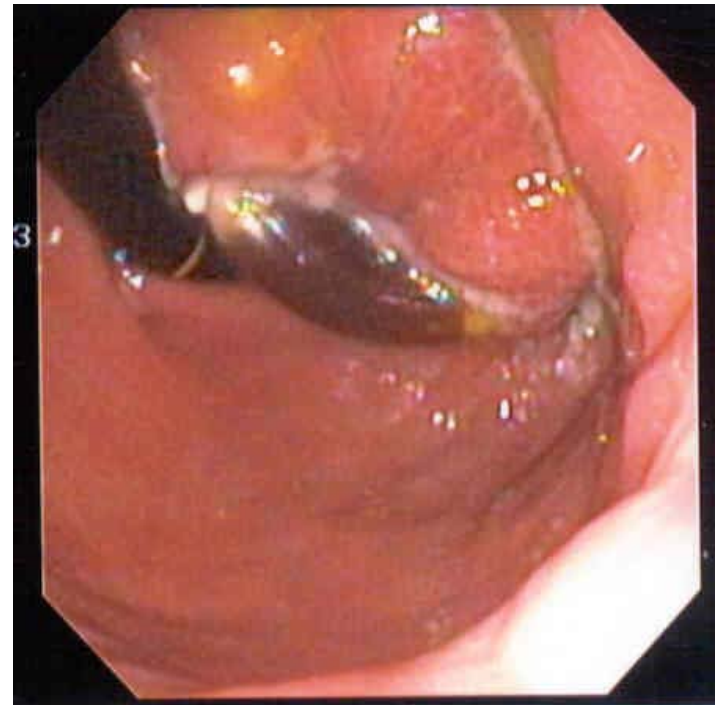


Gastric Prolapse



Band Erosion

- Presentation:
 - Asymptomatic
 - Latent port site infection
 - Lack of restriction
 - Acute abdomen
- Index of Suspicion
- Diagnosis by EGD

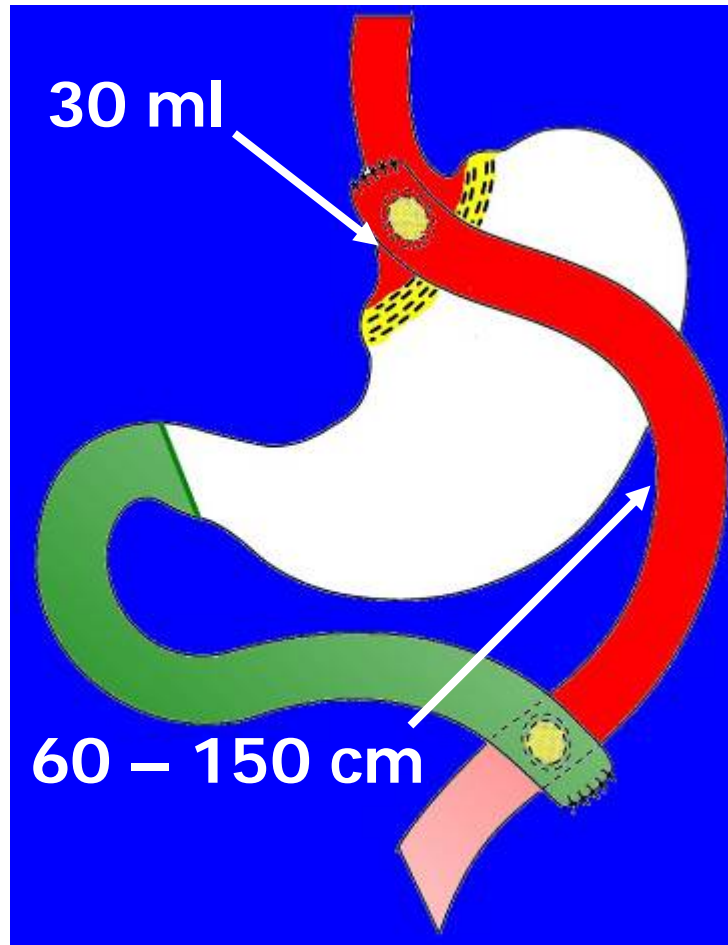


Obstruction / Esophageal Dilation



- Obstruction may be relieved by band deflation.
- Esophageal dilation may initially be asymptomatic but lead to permanent motility problems.
- Yearly esophagram is recommended in lap band patients.

Roux-en-Y Gastric Bypass





GI – Complications Gastric Bypass

- **Abdominal Pain / Nausea**

Marginal ulcer

- **Obstruction (Nausea / Vomitting / Abdominal Pain)**

Internal hernia

Anastomotic stricture

Adhesions

- **Weight Gain**

Staple line disruption / gastrogastic fistula

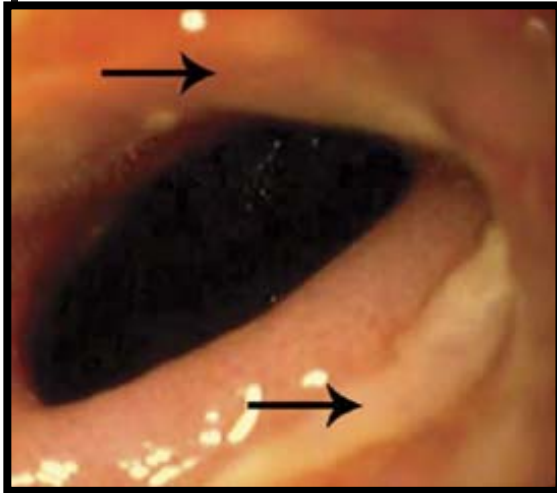
- **Diarrhea**

Dumping syndrome

Small bowel bacterial overgrowth

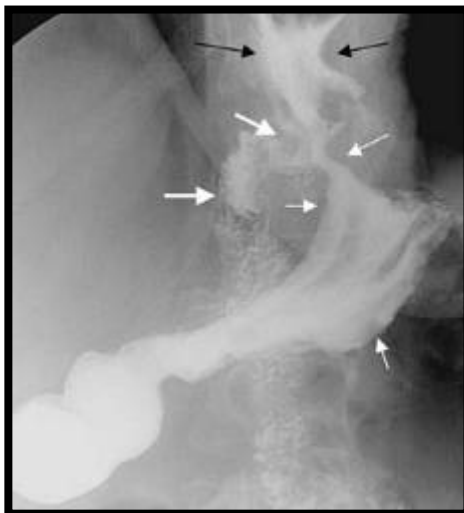
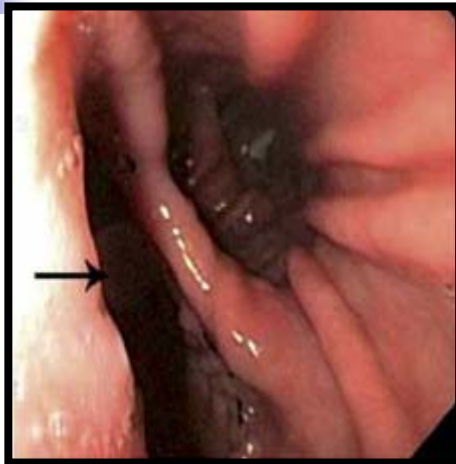
Bile acid diarrhea

Marginal Ulcer



- Incidence 3%-15%.
- Pain, nausea, anemia, rarely bleeding.
- **Causes:**
 - Acid (large pouches)
 - Gastrogastric fistula
 - Roux-limb tension
 - Ischemia
 - NSAIDS
 - H. pylori
 - Smoking
- **Treatment:** Risk Factor Modification +
 - Proton Pump Inhibitor (pH < 4)
 - Carafate (pH > 4)
 - Surgery

Staple Line Disruption & Gastrogastric Fistula



- Related to ulcer.
- Weight regain.
- Less frequent in divided stomachs.
- A reversal method.

Anastomotic Stricture

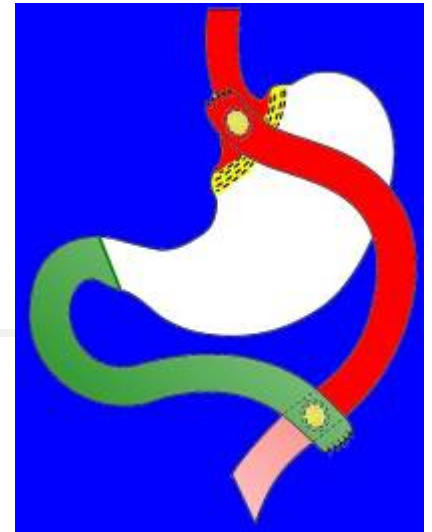


- Incidence 1%-15%.
- Nausea, vomiting, obstruction.
- Usually occurs at the GJ.
- Defined as the inability to pass a 9 mm endoscope.
- Treatment is dilation with a TTS balloon dilator to 12 mm.

Anastomotic Stricture



Internal Hernia



- Incidence 2%-5%.
- Intra-abdominal spaces are created during surgery and enlarge with weight loss.
- The intestine migrates into an intra-abdominal space and obstructs.
- Variety of presentations.
- Exploratory surgery.



Explosion # 1





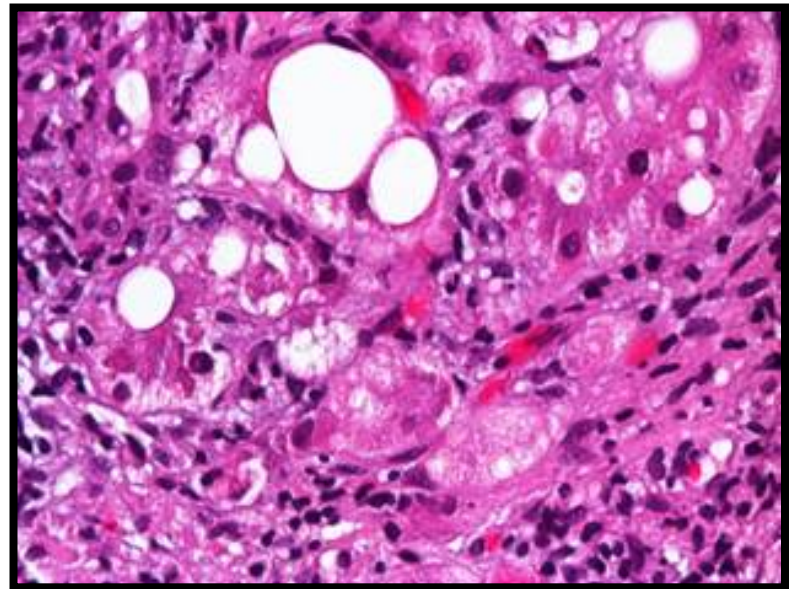
Diarrhea



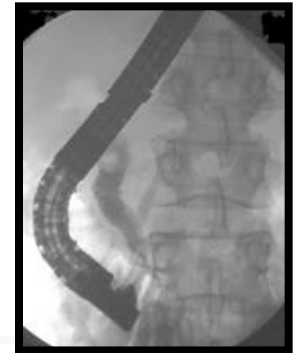
- Usual causes should be excluded.
- **Dumping Syndrome:** Postprandial lightheadedness, flushing, watery diarrhea. Start meals with protein, avoid simple sugars. Octreotide for refractory cases.
- **Small Bowel Bacterial Overgrowth:** Postprandial bloating. Breath test or EGD with small bowel aspirate for quantitative culture. Rotating antibiotics.
- **Bile Salt Toxicity:** Watery diarrhea. Cholestyramine.

GI Complications of Both Lap Band and Gastric Bypass

- Gallstones
- Non-alcoholic Fatty Liver Disease (NAFLD)

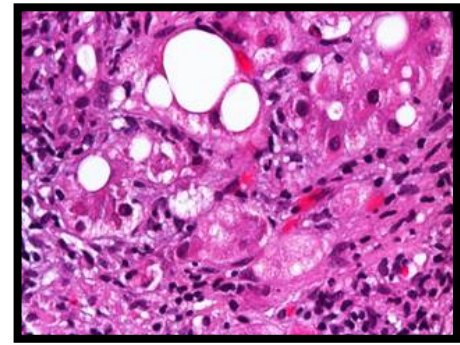


Cholelithiasis



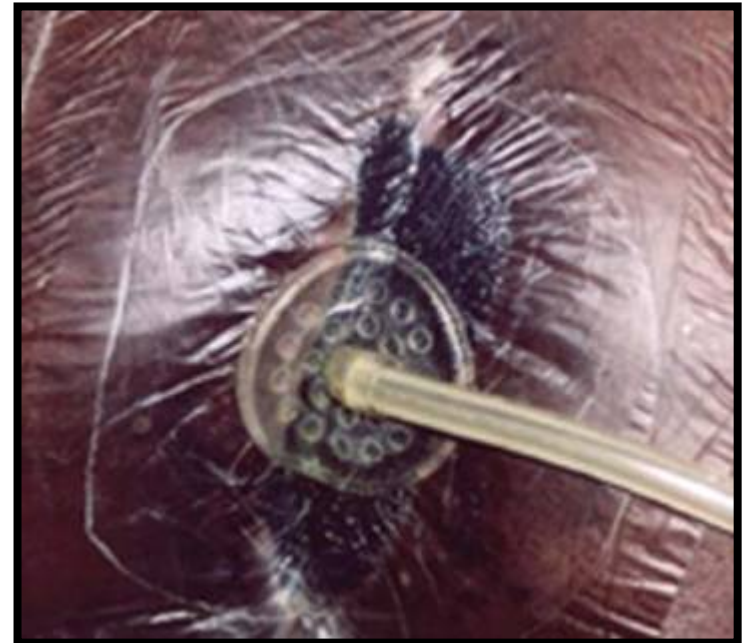
- 25% bariatric patients have had a prior cholecystectomy.
- 25% have cholelithiasis noted on their pre-operatively.
- 10%-42% of patients without gallstones will develop them.
- 32.5% of surgeons perform concomitant cholecystectomy.
- Ursodiol 600 mg daily for 6 months reduced postoperative gallstone formation from 32% to 2%, but its use is limited by cost (\$600 yearly) and non-compliance.
- ERCP is difficult after gastric bypass and may require laparoscopic access to the stomach.

NAFLD



- Incidence: NAFLD 91%
NASH 37%
unexpected cirrhosis 1.7% (1-7%)
- Hepatomegally makes bariatric surgery technically difficult. A pre-operative very low carbohydrate diet may reduce left lobe liver volume making surgery easier.
- Bariatric surgery can potentially reverse fatty cirrhosis.
- However, the initial rapid weight loss following bariatric surgery can cause hepatic decompensation in patients with NASH.

Explosion # 2





Malnutrition in Obesity Before Bariatric Surgery

■ **CAUSES:**

- Over ingestion of low-nutrient high-calorie foods.
- Low ingestion of high nutrient-density foods (vegetables, dairy, legumes, whole grains, fish, nuts, etc.).
- High fat diets with low Vitamin A, C, and folate.
- Low sun-light exposure due to decreased activity causing low vitamin D.
- Low-grade chronic inflammatory state.
- Type-II DM increasing renal hyperfiltration with micronutrient loss.

Prevalence of Malnutrition in the Obese Before Bariatric Surgery

Nutrient	% with deficiency	Comment
Vitamin D < 20 ng/mL	Winter: 91%, Summer: 24%	Worse with dark skin
Vitamin A	12.5%	
Vitamin E	23%	
Folic Acid	0 – 6%	
Vitamin B ₁₂	18%	
Vitamin B ₁	7 – 47%	Worse in H > AA > C
Vitamin C	36%	
Iron	44%	Worse in Female > Male
Zn	28%	
Se	6 - 58%	
Vitamin B ₂ and B ₆	No se sabe	
Copper	No se ha encontrado	



Recommended Studies Before Bariatric Surgery

J Clin Endocrinol Metab 95:4823-4843,2010

- Complete Hemogram
- Liver Enzymes
- Glucose
- Creatinine
- Electrolytes
- Fe, Transferrin, Ferritin
- Vit B12
- Folate
- Ca
- Intact PTH
- 25-OH D
- Albumin/Prealbumin
- Vitamin A
- Zn
- Bone Mineral Density & Body composition
- Consider: thiamine, Se, Vitamin E, Vitamin C.



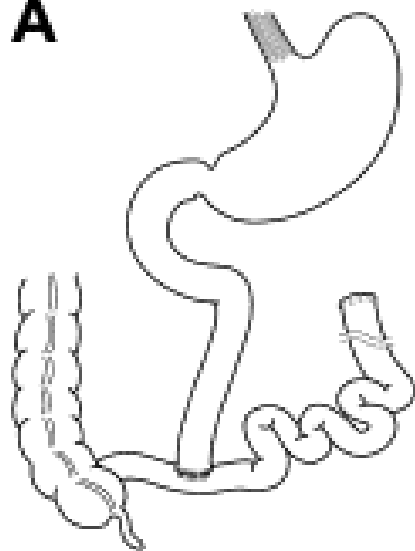
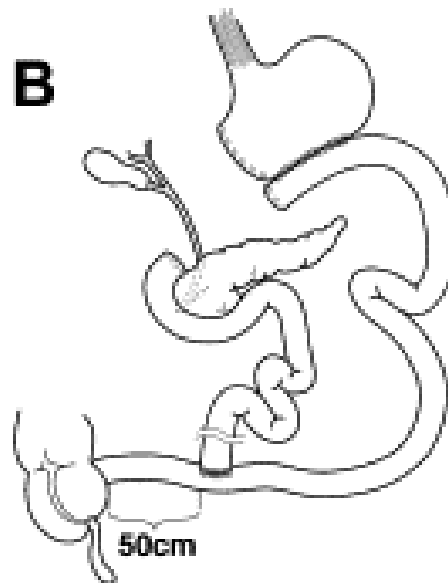
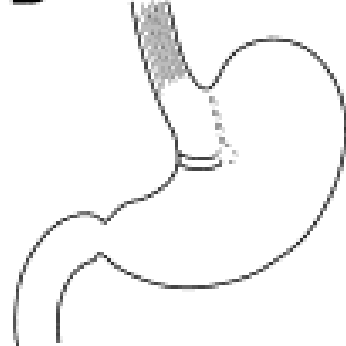
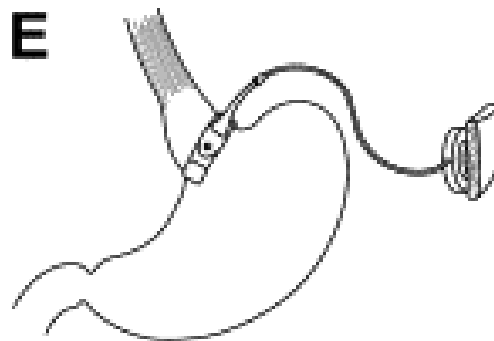
Nutritional Considerations

- Preop
 - Mandatory 6 month weight loss programs
 - VLCD
 - Correction of nutritional deficiencies.
- Immediate Post-Op
 - Liquids-- minimize trauma, maximize healing
- Long term
 - Food intake less than before
 - Well balanced, small portions
 - 64 oz. fluid daily
 - 60-120 grams of protein daily

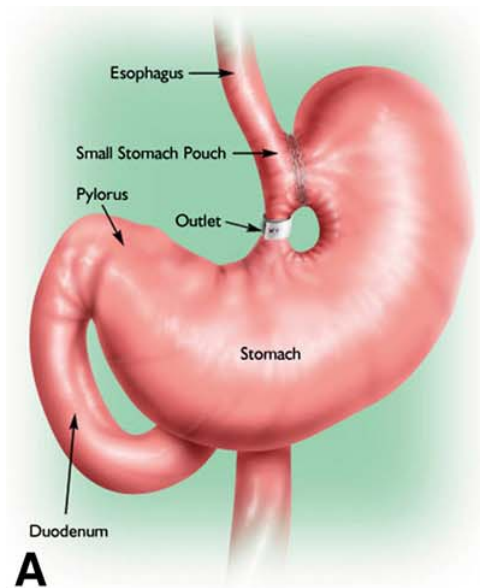


Types of Bariatric Surgeries

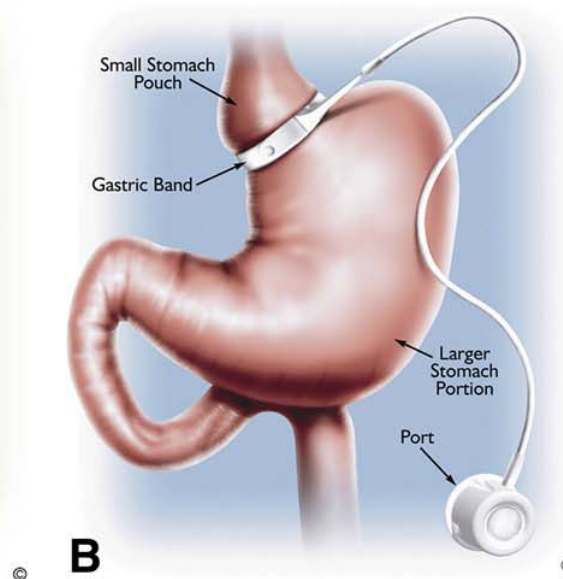
- **Purely Restrictive:** affect Fe, Se & B₁₂ absorption
 - Vertical Banded Gastroplasty
 - Adjustable Gastric Band (AGB and LAGB)
 - Vertical Sleeve Gastrectomy (VSG)
- **Mostly Restrictive** (some malabsorption):
 - Roux-en-Y Gastric Bypass (RYGB)
- **Mostly Malabsorptive** (some restriction):
 - Jejunio-Ileal Bypass (not done anymore)
 - Bilio-Pancreatic Diversion (anastomosis 50 cm from IC valve)
 - **Bilio-Pancreatic Diversion with Duodenal switch** (anastomosis 100 cm from IC valve)

A**Jejunioileal Bypass****B****Biliopancreatic
Diversion****C****Duodenal Switch****D****Vertical Banded
Gastroplasty****E****Adjustable
Gastric Band****F****Roux-en-Y
Gastric Bypass****G****Vertical Sleeve
Gastrectomy**

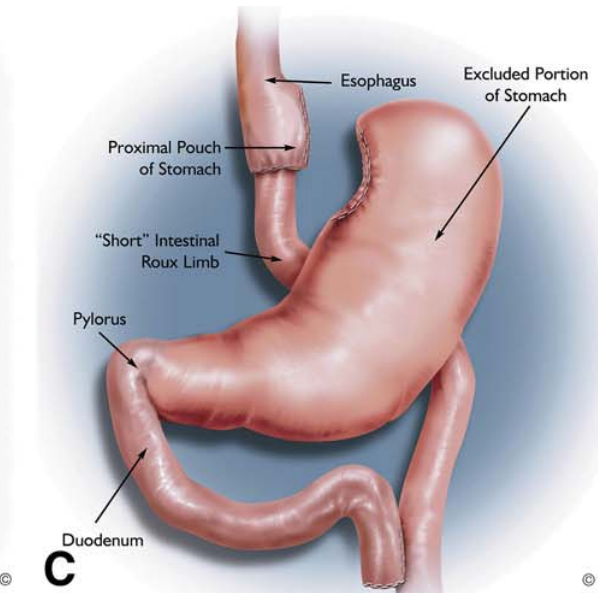
Bariatric Surgical Procedures



Vertical Banded
Gastroplasty

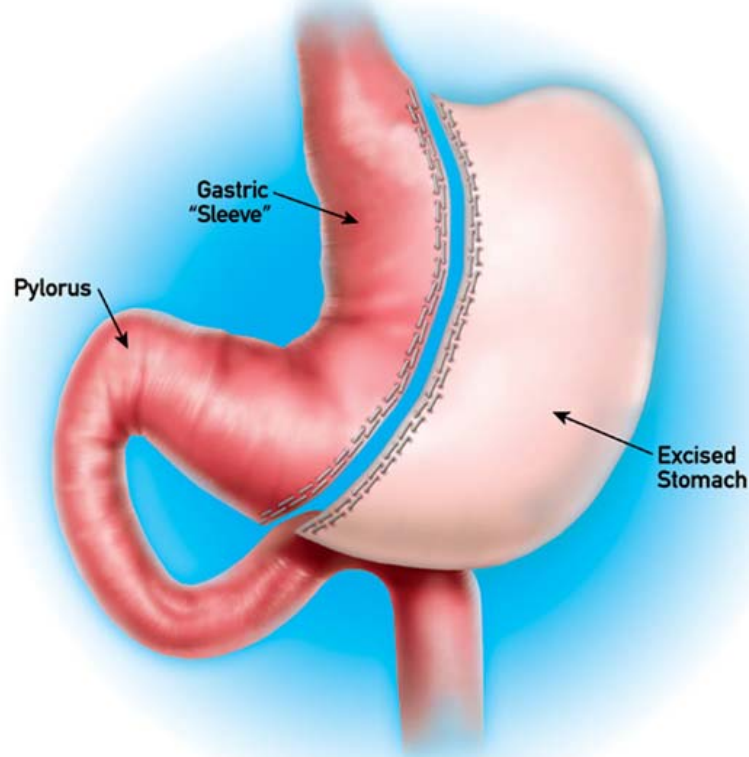


Adjustable Gastric
Band +/- Laparoscopy



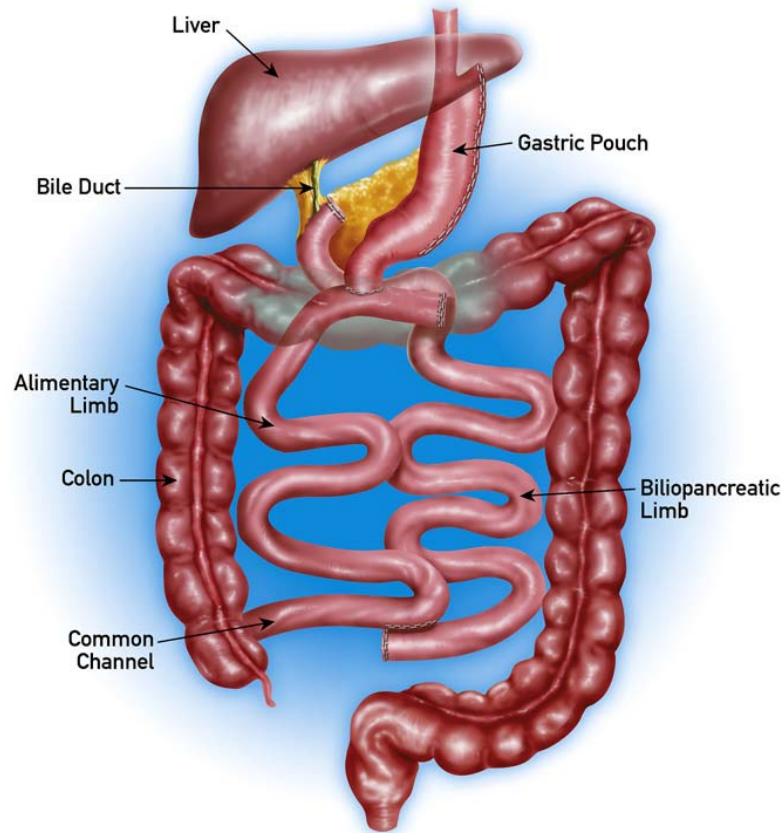
Roux-en-Y Gastric
Bypass

Gastric Sleeve Gastrectomy



Vertical Sleeve Gastrectomy

Bilio-Pancreatic Diversion with Duodenal Switch (100 cm)



Site of Absorption of Micronutrients

Shankar P et al. Nutrition 2010;(26):1031-1037

Site of Absorption	Micronutrient
Stomach	-Copper, Iodine
Duodenum	-Iron, Zinc, Copper, Selenium, Calcium, -Vitamins A, E, K, Thiamine, Riboflavin, Folic Acid, Niacin, Biotin.
Jejunum	-Zinc, Selenium, Iron, Calcium, Chromium, Manganese, -Vitamins A, D, E, K, C, Thiamine, Riboflavin, Pyridoxine, Folic Acid, Niacin, Panthotenic Acid
Ileum	-Vitamins C, D, K, B ₁₂ , Folic Acid.



Clinical Presentation of Nutritional Deficiencies After Bariatric Surgery

- **Edema:** Protein malnutrition, Vit C.
- **Skin Rash:** Vit A, vit B6, Vit B2, Vit C, Zn, Biotin.
- **Hair loss:** protein malnutrition, Zn, Biotin.
- **Stomatitis/glossitis:** Fe, Folate, Vit B6, vit B2.
- **Altered Taste:** Zn, Cu.
- **Night blindness:** Vit A, Zn.
- **Diarrhea:** Folate, Zn.
- **Anemia:** Fe, Vit E, Folate, vit B12, Thiamine, Vit B6, Cu.



Clinical Presentation of Nutritional Deficiencies After Bariatric Surgery

- **Neuropathy:** Vit E, Vit B12, Thiamine, Vit C, Cu, Biotin.
- **Abnormal gait:** Thiamine, Vit D, Cu, Biotin.
- **Muscular weakness:** Vit D, Vit E, Thiamine, Vit C, Se.
- **Osteomuscular pain:** Vit D, Vit C.
- **Depression, Memory problems, Confusion:**
Vitamin B12, Folate, Thiamine, Vit B6, Biotin, Zn.
- **Encephalopathy:** Thiamine, vit B12, Cu, Carnitine,
uncovering of Urea Cycle Disorder (ornithine transcarbamylase
deficiency)
- **Cardiomyopathy/ Heart Failure:** Thiamine, Se.
- **Poor wound healing:** protein malnutrition, Vit C.



Macronutrient Deficiency Post Bariatric Surgery

- **Dehydration:**

- **Frequency:** rare in absence of diarrhea and vomit.
- **Management:** Correct anatomic lesions associated with anastomotic strictures.

- **Protein-Calorie Malnutrition and Hypoalbuminemia:**

- **Frequency:**
 - Bilio-pancreatic Diversion+/-Duodenal Switch (BPD+/-DS): up to 18%.
 - Gastric Bypass with Roux-en-Y (RYGB) with loop > 150 cm: 13%,
 - Gastric Bypass with Roux-en-Y (RYGB) with loop < 150 cm: < 5%.
- **Clinical Manifestations:** edema, alopecia, y slow wound healing.
- **Monitoring:** Check Albumin + Pre-albumin twice a year after RYGB and BPD+/-DS.

GVB = Gastroplastía vertical con banda; BGA y BGAL = banda gástrica ajustable (abierta o laparoscópica); GVM = gastrectomía vertical en manga; BGRY = bypass gástrico con Roux-en-Y; DBP+/-CD = derivación bilio-pancreática +/- cambio duodenal



Macronutrient Deficiency Post Bariatric Surgery

■ Management of Protein-Calorie Malnutrition:

- Eat 60-120 gm protein per day, divided in servings of ≥ 30 gm each in at least 2 to 4 meals (to start protein repletion).
- Protein-calorie malnutrition is difficult to correct:
 - Patients can not eat fast nor in large volume
 - May need temporary TPN.
- In extreme or refractory cases: surgical revision or reversal of surgery.

Prevalence (%) of Micronutrient Deficiencies After Bariatric Surgery

Mount Sinai J of Medicine 77:431-445,2010

	VSG	LAGB	RYGB	BPD +/- DS
Thiamin B1	0	0	12	0
Pyridoxine B6	0	14	10	N/A
Folate	22	10	0-12	5
Cobalamine B12	18	0-19	33-58	22
Vitamin C	N/A	48	10-50	N/A
Vitamin A	N/A	10-25	10-52	61-69
Vitamin D < 30	32	30-40	30-50	40-100
Vitamin E	N/A	0-11	0-22	4-5
Vitamin K	N/A	N/S	N/A	68
Iron	14	0-32	25-50	21-26
Zn	34	N/A	37	10-50
Se	N/A	N/A	3	14.5
Cu	N/A	N/A	N/A	70



Prevention of Micronutrient Deficiencies after Bariatric Surgery

- Supplementation with micronutrients (vitamins and minerals) must be done with **non enteric-coated** products.
 - Best are chewable tablets, liquid preparations, or non enteric coated tablets dissolved in water for 30 minutes.
 - **Dose after purely restrictive surgery** (AGB, LAGB, VBG, VGS): at least 1 tablet a day of "Multivitamins + Minerals"
 - **Dose after de Malabsorptive or mix surgery** (RYGB, BPD+/-DS): at least 2 tablets a day of "Multivitamins + Minerals"
 - **Additional for all patients** ("Multivitamins + Minerals" are not enough to cover needs:
 - Calcium Citrate 1200-2000 mg;
 - Vitamin D 400-800 UI;
 - Folic Acid 400 mcg;
 - Iron (elemental) 40-65 mg;
 - Vitamin B₁₂ 350 mcg daily p.o., or 1000 mcg IM monthly, or 500 mcg endo-nasal weekly.

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Micronutrient Deficiency Post Bariatric Surgery

- **Fe deficiency** occurs in 12-47% after RYGB. More frequent after BPD+/-DS.
 - More frequent in females and in younger age < 25 (79%).
 - Routine Multivitamin/Mineral preparations are NOT enough to correct Fe deficiency;
 - Deficiency may cause weakness, fatigue, headaches, dizziness, pallor, restless legs, brittle nails, sore tongue and dysphagia.
 - Need oral Fe sulfate 325 mg (65 mg Fe) BID or TID with Vitamin C, or IV Fe.
 - Monitor Fe, TIBC, Ferritin twice a year.



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin D deficiency** in 45% after RYGB (more in BPD+/- DS).
 - Deficiency causes osteomalacia with aching pain in lower spine, hips, pelvis, legs, and ribs. May give weakness of arm and legs with waddling gait.
 - Prevention: Give Vitamin D3 1000 -5000 IU/d to maintain levels.
 - If deficient, needs 50000 IU/day until normalization, then 5000 IU/d.
 - Monitor plasma 25OH-D twice a year after RYGB or BPD+/-DS



Micronutrient Deficiency Post Bariatric Surgery

- **Calcium depletion:** calcium levels are usually normal but elevated intact PTH is common (29% after RYGB, 63% after BPD+/-DS).
 - Clinical hypocalcemia is rare because of secondary hypoparathyroidism, which increases bone resorption. Administration of biphosphonates without previous correction of low vitamin D and without Calcium supplements may trigger symptomatic hypocalcemia.
 - Prophylaxis: Oral intake of 1200– 2000 mg/d of Ca Citrate is recommended.
 - Monitor intact PTH twice a year after RYGB, & BPD+/-DS.



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin A deficiency** is rare and mild after RYGB; after BPD+/-DS deficiency occurs in 61-69%.
 - May cause xerophthalmia, nyctalopia (night blindness) and follicular hyperkeratosis.
 - Supplements of 5000-10000 IU/d are recommended after bilio-pancreatic diversion.
 - Monitor twice yearly Plasma Retinol after BPD+/-DS. (Normal = 28-86 mcg/dL).

Vitamin A Deficiency: Follicular Hyperkeratosis



Fig. 4 Follicular hyperkeratosis resulting from vitamin A deficiency resembles "gooseflesh" but can be distinguished from it because the bumps do not disappear when the skin is rubbed. These lesions commonly appear on the lateral surface of the arm and extensor surface of the thigh.



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin E deficiency** occurs in 7.1% after BPD.
 - May cause sensory neuropathy, spinocerebellar ataxia, areflexia, skeletal myopathy and hemolytic anemia.
 - Monitor twice yearly plasma alfa-tocopherol after BPD+/-DS (Normal alfa tocopherol > 5mcg/mL or 0.8 mg/g total lipids)
 - Prevention: 400 IU/day after bilio-pancreatic diversion.



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin K deficiency** occurs in 68% after BPD.
 - May cause easy bleeding or bruising.
 - Monitor twice yearly PT after BPD+/-DS.
 - Prevention: 1 mg/day after bilio-pancreatic diversion



Micronutrient Deficiency Post Bariatric Surgery

- **Folic Acid deficiency** is rare after Bariatric Surgery, due to bacterial production of folate and use of multivitamins.
 - Deficiency causes macrocytic anemia, glossitis, diarrhea, depression, confusion, palpitations, fatigue and, in pregnancy, neural tube defects. Recommend 400 mcg/day (in multivitamins). If deficient, give 1 mg/day.
 - Monitor plasma or RBC folic acid and for elevated homocysteine (also affected by B12, B6, renal insufficiency and genetics) twice a year.



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin B12 deficiency** is common after RYGB (30-40%).
 - Deficiency causes Pernicious Anemia, paresthesias, neuropathy, depression, paranoia, delirium, and dementia.
 - Prevention: Supplement with oral 350 mcg/d, 1000 mcg IM q 3 months, or 1000 mcg/week intranasal.
 - Monitor plasma B12 twice a year after RYGB, or BPD+/-DS. In low-normal values (200-350 pg/mL), an elevated serum Methylmalonic acid supports B12 deficiency (in absence of renal failure).
 - Treatment of symptomatic deficiency: 1000 mcg/d IM x 5 days, then 1000 mcg IM every 3 months, or 1000 mcg/week intranasal.



Micronutrient Deficiency Post Bariatric Surgery

- **Thiamin or Vitamin B1 deficiency** occurs in 18% after RYGB.
 - May occur after as little of 2 weeks of persistent vomiting or as a result of bypass of the jejunum
 - Deficiency may cause:
 - Peripheral neuropathy, fatigue, irritability,
 - Wernicke encephalopathy (ophthalmoplegia, nystagmus, ataxia, apathy, coma),
 - Korsakoff psychosis (confusion, dysphonia and confabulation),
 - Dry beriberi (bilateral symmetric, stocking-glove distribution paresthesias, dysesthesias, muscular cramps and muscular wasting) ,
 - Wet beriberi (vasodilation, tachycardia, wide pulse, warm skin, lactic acidosis, CHF and shock) and
 - Anemia.



Micronutrient Deficiency Post Bariatric Surgery

- Thiamin or Vitamin B1 deficiency ...
 - Evaluate by measuring erythrocyte transketolase activity and MRI of brain looking for T2 abnormalities in the dorsomedial thalamic nuclei, periaqueductal grey matter and mamillary bodies (sensitivity 53%, specificity 93%).
 - No monitoring required. Investigate after symptoms.
 - Prevention: 50 mg a day
 - Deficiency: Treat with thiamine 500 mg IV 3 times a day x 3 days, then 250 mg IV daily until improved, followed by 50-100 mg 3 times a day orally thereafter.

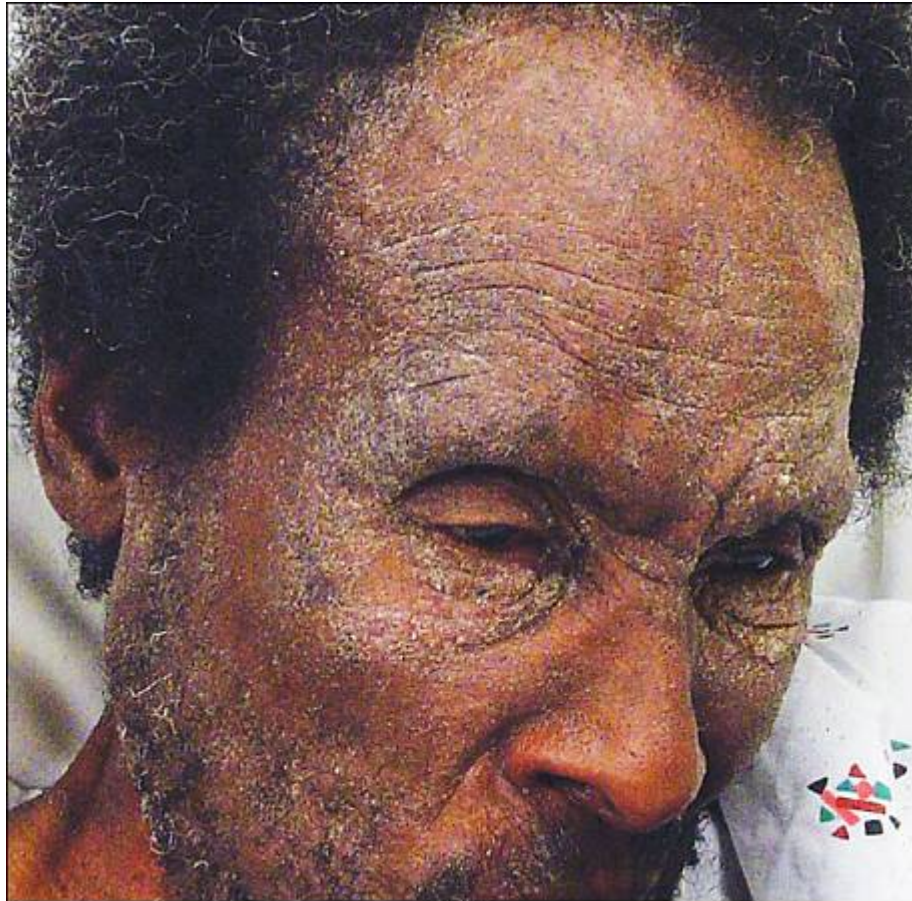


Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin B6 deficiency** occurs in 17% after RYGB.
 - May cause seborrheic dermatitis, glossitis, cheilosis, depression, confusion, EEG abnormalities, and seizures. May also cause anemia (normocytic, microcytic or sideroblastic)
 - Measure plasma pyridoxal-5 phosphate.
 - No monitoring required. Investigate after symptoms.

Vitamin B6 deficiency

Seborrheic Dermatitis



Figure



Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin B2 deficiency** occurs in 13% after RYGB.
 - May cause angular stomatitis, cheilosis, seborrheic dermatitis in naso-labia, eyelids, scrotum and labia majora, lacrimation and photophobia.
 - Measure urinary excretion of riboflavin.
 - No monitoring required. Investigate after symptoms.

Riboflavin (B2) Deficiency

Stomatitis & Cheilosis



Riboflavin (B2) Deficiency

Stomatitis & Cheilosis





Micronutrient Deficiency Post Bariatric Surgery

- **Vitamin C deficiency** occurs in 34% of patients after RYGB
 - Early manifestations are lassitude, weakness, irritability, weight loss, and vague myalgias and arthralgias. Late manifestations are follicular hyperkeratosis, coiled hair, and perifollicular hemorrhages. Wounds heal poorly. May develop femoral neuropathy, leg edema, and painful joint effusions.
 - Could measure plasma ascorbic acid; levels < 0.6 mg/dL are marginal, and < 0.2 mg/dL are deficient.
 - No monitoring required. Investigate after symptoms.
 - Treatment: standard multivitamins BID should be enough.

Vitamin C Deficiency

Perifollicular Hemorrhage and Corkscrew Hairs





Micronutrient Deficiency Post Bariatric Surgery

- **Zinc deficiency** occurs in 36-51% post-bariatric surgery patients.
 - Causes acrodermatitis enteropathica rash, abnormal smell and taste, hair loss, diarrhea, night blindness, and altered memory.
 - Diagnosis is by serum Zn levels.
 - No monitoring required. Investigate after symptoms.

Zinc Deficiency

Acrodermatitis Enteropathica





Micronutrient Deficiency Post Bariatric Surgery

- **Selenium deficiency** is almost universal after JIB, and is found in 28% after LAGB, and 15% after RYGB.
 - Deficiency may cause acute severe heart failure due to selenium-deficient dilated cardiomyopathy. May cause muscular weakness and muscular cramps.
 - Diagnosis: Measure RBC glutathione peroxidase activity, and RBC selenium.
 - No monitoring required. Investigate after symptoms.



Micronutrient Deficiency Post Bariatric Surgery

- **Copper deficiency** can occur after gastrectomy, and is found in 15% after RYGB, but is usually mild.
 - Manifestations are anemia, leukopenia, ageusia, ataxia, myelopathy, and peripheral neuropathy with paresthesias in feet +/- hands.
 - Is diagnosed by serum copper levels.
 - Zn and Fe supplementation may aggravate Cu deficiency.
 - No monitoring required. Investigate after symptoms.
 - Treatment: 6 mg orally daily x 1 week, then 4 mg daily x 1 week, then 2 mg/d thereafter. If oral replacement fails, give IV copper 2 mg/day x 5 days. Then continue oral Cu. Discontinue Zn supplements.

Recommended Periodic Testing After

Bariatric Surgery

J Clin Endocrinol Metab 95:4823-4843,2010

EVERY 6 MONTHS

- Complete Hemogram
- Liver Enzymes
- Glucose
- Creatinine
- Electrolytes
- Iron/Ferritin/Transferrin
- Vitamin B12
- Folic Acid
- Calcium
- Intact PTH
- 25-OH Vit D
- Albumin/Prealbumin

OPTIONAL

- Vitamin A
- Zinc
- Vitamin B1 (thiamine)
- Other tests trigger by symptoms (Cu, Se, Cr, ...)

Vitamins and Minerals



- Micronutrient deficiencies are common pre-operatively due to a nutrient-poor diet and renal losses from obesity and diabetes associated renal hyper-filtration.
- Post-operatively, reduced food intake and absorption compound the problem.
- For example, up to 30% of patients may be zinc deficient pre-operatively.
- Other key nutrients include: iron, folate, B12, calcium, vitamin D, thiamine.



Neurologic Complications

- Experienced by 4.6% of bariatric surgery patients.
 - Peripheral neuropathy 62%, encephalopathy 31%
- **B12**: 24%-70% (1-7 yr); paresthesias, ataxia, weakness
- **Thiamine**: 18% (1 yr); neuropathy, encephalopathy
- **Pyridoxine**: 18% (1 yr); neuropathy, seizures, confusion
- **Vitamin D**: osteomalacic myopathy
- **Vitamin E**: sensory neuropathy / myopathy
- **Copper**: myeloneuropathy, ataxia, neuropathy, ageusia
- **Carnitine**: encephalopathy
- **Vitamin C**: femoral neuropathy
- **Zinc**: night blindness, dysgeusia.
- **Others**: Vitamins B3, B5 and B7; chromium.
- *Am Surg.* 2006 Dec;72(12):1196-202; *Muscle Nerve.* 2006 Feb;33:166-176.



Acute Post Gastric Reduction Surgery Neuropathy

Bariatric Beriberi / APGARS Neuropathy

- Painful symmetric sensorimotor lower extremity polyneuropathy with objective weakness and often with hyporeflexia, “burning feet syndrome”, and/or vomiting.
 - Typically occurs after protracted vomiting (ulcer, stricture).
 - Frequently misdiagnosed as Guillain Barré syndrome.
- **Incidence:** 3.6% at 14 months, 4.6% at 20 months.
- **Surgery:** gastric bypass > gastric banding.
- **Micronutrient deficiencies:** thiamine, B12;
 - possibly others (B7 Biotin, B6 pyridoxine, B5 pantothenic acid, B3 niacin, vitamin E, copper, chromium, carnitine).
- **Treatment:** Vitamins, nutrition support +/- IV immunoglobulins.



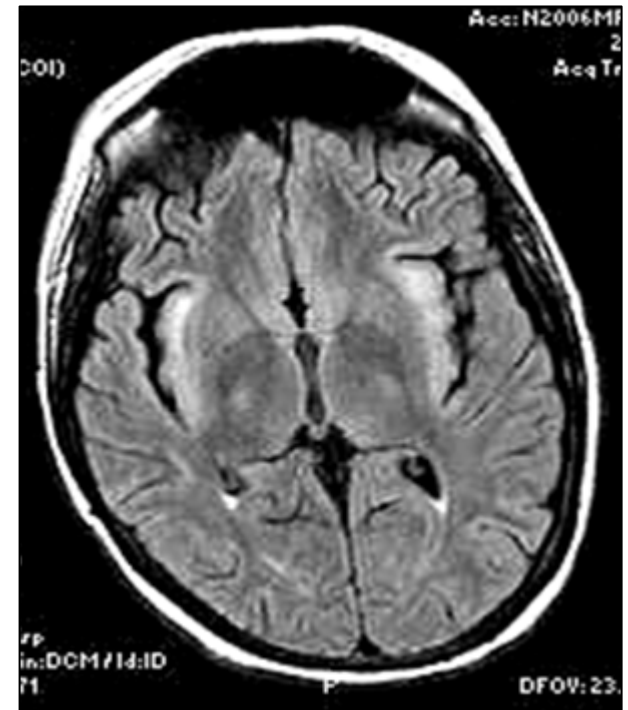
Initial Treatment of APGARS

Rudnicki SA. Curr Treat Optio Neurol 2010;12:29-36

- **Thiamine:**
 - 500 mg IV 3 times a day x 3 days; then
 - 250 mg IV a day until improvement; then
 - 50-100 mg oral 3 times a day long term.
- **Vitamin B₁₂:**
 - 1000 mcg IM/day x 5 days; then
 - 1000 mcg IM/month
- **Copper:** Give for documented deficiency:
 - 6 mg/day po x 7 days; then
 - 4 mg/day x 7 days; then
 - 2 mg/day.
 - If levels do not improve, give elemental IV copper 2 mg/day x 5 days;
 - Then, maintain with copper po 2 mg/day.

Wernicke's Encephalopathy

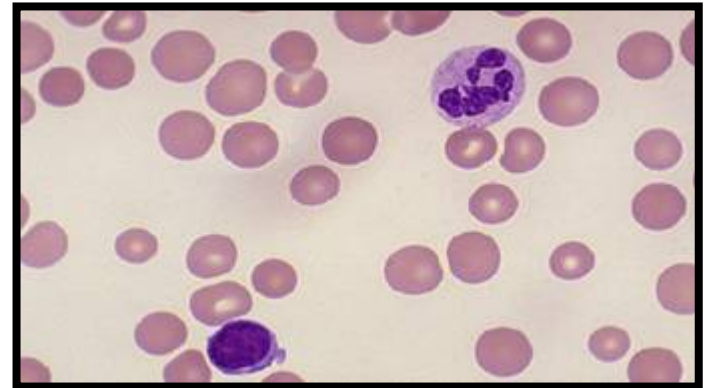
- Arises in the setting of APGARS neuropathy.
- Requires 2 of 4:
 - dietary deficiency
 - oculomotor abnormalities
 - cerebellar dysfunction
 - impaired mental status
- MRI 53% sensitive and 93% specific
- Parenteral thiamine



- *Muscle Nerve*. 2006 Feb;33:166-176.
- *Arch Neurol*. 2004 Aug;61(8):1185-9.
- *J Neurol Neurosurg Psychiatry*. 1997 Jan;62(1):51-60.
- *AJR Am J Roentgenol*. 1998 Oct;171(4):1131-7.

Hematologic Complications

- Anemia occurs in 37% of patients. It occurs earlier (6 mo vs. 1 yr) and more commonly in menstruating women than men.
- Iron: 16% (estimate)
- B12: 24%-70%
- Folate: 40%
- Copper, Pyridoxine
- The most common endoscopic findings:
 - #1 Normal 35%
 - #2 Marginal Ulcer 25%



Gastroenterol Clin North Am. 2005 Mar;34(1):25-33. *Obes Surg.* 1999 Apr;9(2):150-4.
Muscle Nerve. 2006 Feb;33:166-176. *Obes Surg.* 2006 Sep;16(9):1232-7.

Endocrine Complications

- **“Bypass Bone Disease”**

- Vitamin D deficiency (63% yr 4) & calcium depletion may lead to secondary hyperparathyroidism (50% yr 20) and biopsy proven osteomalacia (20%).
- Symptoms: diffuse bone pain (microfractures) but may also feature weakness from a proximal myopathy, arthralgia, synovitis.
 - X-Ray: pseudofractures with Looser’s lines

- **New onset diabetes.**

- Chromium deficiency.

- *Gastroenterol Clin North Am.* 2005 Mar;34(1):25-33.
Gastrointest Surg. 2004 Jan;8(1):48-55



Cardiac Complications



- Non-ischemic Dilated Cardiomyopathy
- #1 Bariatric Beriberi
- #2 Keshan Syndrome



- *Heart Lung Circ.* 2007 Apr;16(2):123-6.

Conclusions



- The prevalence of obesity is still rising.
- The number of bariatric surgeries is rising accordingly.
- Gastrointestinal and nutritional complications of the surgeries are common and may present years later.
- Given the “Center of Excellence” model, the internist should be prepared to diagnose and treat these problems.
- No matter what the presentation, always consider the possibility of nutritional deficiency.