Objectives

- Describe the effects of bariatric surgery on obesity comorbidities and mortality
- Identify basic eligibility criteria for surgery
- Discuss potential long-term complications of bariatric surgery
- Apply recommendations for post-op medical and nutritional management
Case 1

46 y.o. woman w/ severe obesity, type 2 DM, HTN, GERD

- Wt increased from 240 to 280 lbs over last 10 years (BMI 40 to 46 kg/m\(^2\))
- Lost 20 lbs with Weight Watchers then regained 10 lbs
- Walks 30 min 3 times/week

Weight loss surgery?

Case 2

61 y.o. man with obesity, type 2 diabetes

- 423→375 lbs (BMI 54→48 kg/m\(^2\))
- Roux-en-Y gastric bypass surgery
  - 240 lbs (BMI 31)
  - Insulin discontinued
- New low back pain

Why did he fracture?
Obesity is an important and growing public health problem

- US adults: 34% obese, 6% with BMI ≥40 kg/m²
- Lifestyle changes usually do not result in clinically meaningful and sustained wt loss
  - Rarely of the magnitude needed for those with extreme obesity

1NCHS 2014

Wadden, N Engl J Med 2011
Growing demand for bariatric surgery

- 25,000 operations in 1998 → 220,000 in 2009

American Society for Metabolic and Bariatric Surgery

Malabsorptive

- Biliopancreatic diversion with duodenal switch

Restrictive

- Adjustable gastric band

DeMaria, N Engl J Med 2007
DeMaria, N Engl J Med 2007

Comparative weight loss outcomes

Buchwald, JAMA 2004
Type 2 diabetes

- Completely resolved in 77%, and resolved or improved in 86%\(^1\)
  - 84% resolved after RYGB, 48% after gastric banding
- Resolution often occurs days after RYGB, even before marked weight loss\(^2\)
- Weight-dependent and weight-independent mechanisms

\(^1\)Buchwald, JAMA 2004; \(^2\)Rubino, Ann Surg 2004
Why does diabetes improve/resolve?

• All procedures: Weight loss
  ▫ \( \downarrow \) Weight \( \rightarrow \) \( \downarrow \) Insulin resistance
• RYGB: Additional endocrine effects\(^1\)-\(^3\)
  ▫ \( \uparrow \) GLP-1 \( \rightarrow \) \( \uparrow \) Insulin secretion
    • “Incretin effect”
  ▫ \( \downarrow \) Ghrelin, \( \uparrow \) PYY \( \rightarrow \) \( \downarrow \) Hunger, \( \uparrow \) satiety

\(^1\)Rubino, Ann Surg 2004; \(^2\)Laferriere, JCEM 2008; \(^3\)Cummings, JCEM 2004

Diabetes RCTs

1. More diabetes remission with RYGB (75%) and BPD (95%) than conventional medical tx (0%) at 2 yrs\(^1\)
2. 150 obese pts w/ uncontrolled DM underwent intensive medical therapy +/- RYGB or sleeve gastrectomy\(^2\)
  ▫ 12% (medical tx alone) vs. 42% (RYGB) vs. 37% (sleeve) had A1c <6.0% at 12 months

\(^1\)Mingrone, NEJM 2012; \(^2\)Schauer, NEJM 2012
• Adjusted HR 0.47 (0.29-0.76) for CV deaths
• Adjusted HR 0.67 (0.54-0.83) for CV events

Sjostrom, JAMA 2012
- 29% reduction in risk after 10 years

Sjostrom, NEJM 2007

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Bariatric surgery: Eligibility criteria

NIH criteria:
- BMI $\geq 40$ kg/m$^2$, or BMI $\geq 35$ kg/m$^2$ with an obesity-related co-morbidity
- Failure of lifestyle/medical weight control
- Absence of psychological or medical contraindications
  - Undertreated psychiatric conditions
  - Low likelihood of adherence to post-op requirements
  - Poor coping strategies, lack of social support
  - Eating disorders

Additional exclusion criteria (varies by practice):
- $>400$ lbs, tobacco or other substance use/abuse, CHF or pulmonary HTN not responsive to medical therapy, O2-dependent COPD, cirrhosis
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Acute post-operative care

- Monitor for post-op complications
  - Heart rate
  - Temperature
  - Hypoxia
  - Drain output
- Early ambulation
- DVT prophylaxis
- Opiate PCA / Vicodin
- Advance diet
- Ursadiol

Potential metabolic and nutritional complications

- Weight regain
- Micronutrient deficiencies
- Protein deficiency
- Dumping syndrome
- Gallstones
- Nephrolithiasis
- Acute gout
- Bone loss
- Hypoglycemia
Micronutrient deficiencies

- Vitamin B12
- Calcium, vitamin D
- Iron
- Thiamine
- Folic acid
- Vitamin A
- Vitamin K; zinc; selenium; copper

Potential metabolic and nutritional complications

- Weight regain
- Micronutrient deficiencies
- Protein deficiency
- Dumping syndrome
- Gallstones
- Nephrolithiasis
- Acute gout
- Bone loss
- Hypoglycemia

Malabsorption

Less food

Different food
Dumping syndrome

- Abdominal cramping, nausea, diarrhea, lightheadedness, flushing, tachycardia
- Concentrated sweets → hyperosmolarity of intestinal contents → influx of fluid into intestinal lumen?
- Role of gut peptides?
- Perhaps 75% of gastric bypass pts
- Often transient issue, early post-op period

Heber (Endocrine Society), JCEM 2010

---

Dumping vs Hypoglycemia

<table>
<thead>
<tr>
<th>Dumping syndrome</th>
<th>Hypoglycemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurs early after eating (~30 min)</td>
<td>Occurs 1-3 hours postprandially</td>
</tr>
<tr>
<td>Develops in early post-op period, often resolving over time</td>
<td>Develops ≥1 year post-op</td>
</tr>
</tbody>
</table>

- Dx of hypoglycemia requires Whipple’s triad
  - Symptoms
  - Low glucose concentration
  - Resolution of sxs with glucose correction

Patti, Lancet Diabetes Endocrinol 2016
### Hypoglycemia: Potential mechanisms

- **Overtreatment with insulin, sulfonylurea**
- **↑ Postprandial insulin secretion**
  - ↑ Intestinal delivery → rapid ↑ glucose
  - ↑ Incretin effect (GLP-1, GIP)
  - ↑ Islet cell mass (partial pancreatectomy)
- **Non-insulin dependent mechanisms**
  - Dysregulated enteroendocrine secretion
  - Altered gut microbiota
  - ↑ Bile acids

*Patti, Lancet Diabetes Endocrinol 2016*

### Potential metabolic and nutritional complications

- Weight regain
- Micronutrient deficiencies
- Protein deficiency
- Dumping syndrome
- Gallstones
- Nephrolithiasis
- Acute gout
- Bone loss
- Hypoglycemia
Weight loss, bone loss, and fracture risk

- Obesity may confer less protection against fracture as previously thought
- Weight loss (involuntary or voluntary) is associated with bone loss and increased fracture risk\(^1-4\)
  - In older women, 2-fold higher risk of hip fracture compared to stable weight

\(^1\)Nielson, J Bone Miner Res 2011; \(^2\)Ensrud, Arch Int Med 1997; \(^3\)Ensrud, J Am Geriatr Soc 2003; \(^4\)Ensrud, JCEM 2005

Bariatric surgery and skeletal health

- Gastric bypass induces abnormalities in bone metabolism
  - Early and sustained ↑s in bone turnover
  - Decreases in bone mineral density (BMD)
- Fewer data for other procedures
  - Biliopancreatic diversion: similar\(^1\)
  - Gastric band: less impact on bone\(^2,3\)

\(^1\)Compston, Gastroenterology 1984; \(^2\)Fish, J Surg Res 2010; \(^3\)Dixon, Obesity 2007
BMD decreases substantially

Bone loss: Potential mechanisms

- **Decreased loading**
- **Nutritional factors**
  - ↓ vitamin D and Ca intake
  - ↓ Ca absorption\(^1,2\)
- **Changes in fat-secreted hormones**
  - ↓ estradiol
  - ↑ adiponectin
- **Loss of muscle mass**

\(^1\) Cifuentes, Am J Clin Nutr 2004; \(^2\) Shapses, Am J Clin Nutr 2013

**Schafer, J Bone Miner Res 2015**
Intestinal Ca absorption capacity decreases precipitously

Schafer, J Bone Miner Res 2015

Concern for early fracture-related morbidity and mortality among bariatric surgery patients
Objectives

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Medication adjustment

• Anticipate potentially abrupt decrease in insulin/oral diabetes med needs
  • Self-monitoring and self-titration
• Anticipate downward titration of antihypertensives
• Caution with meds dosed based on weight (e.g., levothyroxine)
• Caution about malabsorption of meds (e.g., warfarin)
Routine supplements

- **Multivitamin**
  - 1-2 daily

- **Calcium citrate**
  - 1000-1500 mg elemental Ca daily from diet + supp

- **Vitamin D**
  - 800-3000 IU daily

- **Vitamin B12**
  - 350-1000 mcg/day orally or 1000 mcg/month IM/SQ

- **Iron**
  - Menstruating women; take with ascorbic acid

---

Biochemical monitoring

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>Q 6 mo x 2 yrs</th>
<th>Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC, lytes, LFTs, gluc</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>25(OH) vitamin D, PTH</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Iron/ferritin</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Albumin/prealbumin</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Thiamine</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Folic acid, zinc, vitamin A</td>
<td>X</td>
<td>(optional)</td>
<td>(optional)</td>
</tr>
<tr>
<td>Vitamin K, copper</td>
<td>(optional)</td>
<td>(optional)</td>
<td>(optional)</td>
</tr>
<tr>
<td>DXA</td>
<td>X</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Or, consider 1-2 years post-op

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*Heber (Endocrine Society), JCEM 2010; Mechanick (AACE/TOS/ASMBS), Surg Obes Relat Dis 2013*
Other prevention, treatment

- **Protein deficiency**
  - Eat protein first; 60-120 g/d or 1.5 g/kg IBW
- **Gallstones**
  - Cholecystectomy with RYGB, or ursodiol
- **Nephrolithiasis**
  - Hydration; low oxalate diet; oral Ca; KCit
- **Acute gout**
  - Prophylactic therapy in appropriate pts

*Heber (Endocrine Society), JCEM 2010; Mechanick (AACE/TOS/ASMBS), Surg Obes Relat Dis 2013*

Case 2

61 y.o. man with obesity, type 2 diabetes

- 423 → 375 lbs (BMI 54 → 48 kg/m²)
- Roux-en-Y gastric bypass surgery
  - ✔ 240 lbs (BMI 31)
  - ✔ Insulin discontinued
- New low back pain

*Why did he fracture?*
• Not taking Ca or vitamin D supplements
• DXA: Total hip T-score -1.8

<table>
<thead>
<tr>
<th>Ca</th>
<th>Alb</th>
<th>Phos</th>
<th>Cr</th>
<th>25OH D</th>
<th>PTH</th>
<th>24h Uca</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.4</td>
<td>3.6</td>
<td>2.5</td>
<td>1.1</td>
<td>17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Vitamin D repletion course, daily Ca carbonate and vitamin D maintenance

<table>
<thead>
<tr>
<th>Ca</th>
<th>Alb</th>
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<th>Cr</th>
<th>25OH D</th>
<th>PTH</th>
<th>24h Uca</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5</td>
<td>3.5</td>
<td>3.0</td>
<td>1.1</td>
<td>28</td>
<td>80</td>
<td>58</td>
</tr>
<tr>
<td>8.4</td>
<td>3.7</td>
<td>2.8</td>
<td>1.3</td>
<td>34</td>
<td>144</td>
<td></td>
</tr>
</tbody>
</table>

• Increased Ca intake and switched to citrate

Recommendations for bone health
- Check and replete 25(OH)D pre-op
- Universal post-op supplements
  - Multivitamin, calcium (dose?), vitamin D
- Labs q 6 mo x 2 yrs then annually
- Monitor BMD by DXA?
- Post-op exercise/resistance training?
- Pharmacologic therapy for high risk pts?

Heber (Endocrine Society), JCEM 2010; Mechanick (AACE/TOS/ASMBS), Surg Obes Relat Dis 2013
Summary: Role of the endocrinologist

- Pre-op, identify potential candidates and discuss surgery as an option
- Pre-op, screen and address nutritional deficiencies
- Post-op, anticipate prompt adjustments to medications
- Reinforce adherence to supplements
- Monitor clinically and biochemically for metabolic and nutritional complications