Bariatric Surgery and Bone Health

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No conflicts of interest

BMI and Fracture Risk

- Low BMI is associated with low BMD
- Low BMI increases fracture risk
- However, relationship is non-linear:
  - Obesity is less protective than low body weight is risky

BMI and Fracture Risk

- The weak protective effect of higher BMI may even disappear in frank obesity
  - GLOW: Obese women fractured at same overall rates as normal weight women, and had more ankle and leg fractures\(^1\)
- WHO cohorts: After adjustment for their higher BMD, obese women fractured more\(^2\)

\(^1\)Compston 2011, \(^2\)Johansson 2011

Weight Loss, BMD, & Fracture Risk

- Weight loss (involuntary or voluntary) is associated with bone loss and increased fracture risk\(^1\)
  - In older women, 2-fold higher risk of hip fracture compared to stable weight

\(^1\)Ensrud 1997, 2003

Surgical Weight Loss

- Of US adults, 34% are obese, and 6% have BMI ≥40 kg/m\(^2\)\(^1\)
- More and more of the extremely obese are undergoing bariatric surgery
  - 13,386 operations in the US in 1998
  - 121,055 operations in the US in 2004\(^2\)
  - Typical weight loss of 60-100 lbs\(^3\)

\(^1\)NCHS 2008, \(^2\)Zhao 2007, \(^3\)Buchwald 2004

Surgical Weight Loss

\(^1\)DeMaria 2007
Surgical Weight Loss

Bariatric Surgery and Bone Loss

- Roux-en-Y Gastric Bypass (RYGB) induces abnormalities in bone metabolism
  - Early and sustained increases in bone turnover
  - Decreases in BMD
- Fewer data for other procedures
  - Biliopancreatic diversion: similar\(^1\)
  - Gastric band: less impact on bone\(^2,3\)

Gastric Bypass and Bone Loss

- 15 pts followed for 9 months\(^1\)
  - Urine NTX ↑ by 329%
  - Total hip BMD ↓ by 7.8%
- 42 pts followed for 12 months\(^2\)
  - Spine BMD ↓ by 7.4%
  - Total hip BMD ↓ by 10.5%

Percentage change in BMD 6 and 12 months after gastric bypass

Carrasco 2009
Bone Loss: Potential Mechanisms

- Signals about decreased loading
- Changes in fat-secreted hormones
  - Estradiol
  - Adipokines
- Nutritional deficiencies
  - Vitamin D malabsorption
  - Non-vitamin D-mediated calcium malabsorption

Vitamin D Deficiency

- High prevalence pre-operatively
- Malabsorption post-operatively
  - RYGB, BPD, +/- sleeve gastrectomy
- Less food, different food

  → Secondary hyperparathyroidism
  → Bone loss
  → Osteomalacia in severe cases

Vitamin D Deficiency

- High prevalence pre-operatively
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✓ Check and replete 25(OH)D pre-op
✓ Daily Ca + vitamin D supplement
✓ Check 25(OH)D, Ca, alb, phos, PTH, alk phos q 6 mo after malabsorptive surgery

Heber (Endocrine Society) 2010

DXA in the Setting of Obesity

- Max weight of scanners: 275-350 lbs.
- DXA artifacts in obesity
  - Large amounts of soft tissue may ↑ or ↓ apparent spine BMD
  - Fat increases variability of measurements
  - Bone marrow fat may ↓ apparent BMD

- Potential bias in setting of weight loss

1Blake 2009, 2Tohill 1997, 3Van Loan 1998
Options for BMD Assessment

- Perform DXA (if weight allows) and interpret thoughtfully
- DXA of distal radius
- CT BMD (g/cm³) spine
- FRAX calculation without BMD

Case

59 y.o. woman, 2 years s/p gastric bypass
- 350 → 230 lbs (BMI 50 → 33 kg/m²)
- Comorbidities improved (e.g., off insulin)
- Severe back pain: new L1 compression fracture

Why did she fracture? Could the fracture have been prevented?

Case

59 y.o. woman, 2 years s/p gastric bypass
- Vitamin D deficient pre-op
- On 1000 IU daily, 25(OH)D = 32 ng/mL
- Ca 9.0, alb 3.8, eGFR >60, PTH 115
- Urinary Ca 15 mg/24h despite 1200 mg Ca daily (as CaCO₃)
  → Increased Ca intake & switched to Ca citrate
  → PTH normalized

Recommendations

- Check and replete 25(OH)D pre-op
- Multivitamin (all procedures)
- Ca 1200-2000 mg (after malabsorptive surgery – all procedures?) (ideally, citrate)
- Vitamin D₃ 800-2000 IU (after malabsorptive surgery – all procedures?)¹

¹Heber (Endocrine Society) 2010
Recommendations

- Check 25(OH)D, Ca, alb, phos, PTH, alk phos q 6 mo x 2 years then annually\(^1\)
- If PTH high and 25(OH)D low, give vit D
- If PTH high and 25(OH)D ideal, check 24-hr urinary Ca and increase Ca intake and/or switch to Ca citrate
- Encourage protein intake, exercise
- DXA pre-op & annually *(malabsorptive)*\(^1\)
- ? Pharmacologic approaches for high risk pts?

\(^1\)Heber (Endocrine Society) 2010