The Changing Shape of Bariatric Surgery

D. Scott Diamond, MD FACS

Measuring Obesity

- Determined by height and weight
- Comparison to ideal body weight/height

\[ BMI = \frac{\text{weight} (\text{kg})}{\text{height} (\text{m})^2} \]

Various Levels of BMI

What does obesity look like? *based on female 5’4” tall

<table>
<thead>
<tr>
<th>Weight Level</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Weight</td>
<td>19 to 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25 to 29.9</td>
</tr>
<tr>
<td>Obese (Class I)</td>
<td>30 to 34.9</td>
</tr>
<tr>
<td>Obese (Class II)</td>
<td>35 to 39.9</td>
</tr>
<tr>
<td>Morbidly Obese</td>
<td>40 or more</td>
</tr>
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<table>
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<tr>
<th>Weight in pounds</th>
<th>BMI</th>
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<td>130#</td>
<td>BMI 22</td>
</tr>
<tr>
<td>152#</td>
<td>BMI 26</td>
</tr>
<tr>
<td>175#</td>
<td>BMI 30</td>
</tr>
<tr>
<td>205#</td>
<td>BMI 35</td>
</tr>
<tr>
<td>234#</td>
<td>BMI 40</td>
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Obesity Trends Among U.S. Adults

1985

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

No Data <10% 10%–14% 15%–19%

Obesity Trends Among U.S. Adults

1988

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

No Data 10% 10%–14% 15%–19%

Obesity Trends Among U.S. Adults

1991

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

No Data <10% 10%–14% 15%–19%
Obesity Trends Among U.S. Adults
1994
(*BMI ≥ 30, or ~ 30 lbs overweight for 5' 4" person)

10%–14% 15%–19% 20%–24%

Obesity Trends Among U.S. Adults
1997
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10%–14% 15%–19% 20%–24%

Obesity Trends Among U.S. Adults
2000
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15%–19% 20%–24%

Obesity Trends Among U.S. Adults
2001
(*BMI ≥ 30, or ~ 30 lbs overweight for 5' 4" person)

15%–19% 20%–24% 25%–29%

Obesity Trends Among U.S. Adults
2003
(*BMI ≥ 30, or ~ 30 lbs overweight for 5' 4" person)

15%–19% 20%–24% 25%–29%

Obesity Trends Among U.S. Adults
2004
(*BMI ≥ 30, or ~ 30 lbs overweight for 5' 4" person)

15%–19% 20%–24% 25%–29%
Obesity Trends Among U.S. Adults
2008
(*BMI ≥ 30, or ~ 30 lbs overweight for 5’ 4” person)

Prevalence of obesity, diabetes, and
obesity-related health risk factors
Mokdad AH, Ford ES, Bowman BA, et al
2003;289:76-79
Increases in obesity and diabetes among
US adults continue in both sexes, all
ages, all races, and all educational
levels

An “Epidemic Within an Epidemic”

The Future is Now

Children Age 6-11
- 1964 4% obese
- 2000 15% obese

Adolescents
- 1964 4% obese
- 2000 16% obese

Comorbidities
(The diseases that accompany obesity)
- Diabetes
- High Blood Pressure
- High Cholesterol
- Heart disease
- Asthma
- Sleep apnea
- Gallstones
- Liver Swelling (NASH)
- Urinary incontinence
- Acid reflux
- Arthritis and gout
- Infertility and menstrual problems
- High Risk Pregnancy
- Blood Clots
- Depression
- Immobility
- Cancer
- Breast
- Colorectal
- Prostate
- Endometrial
- Accident proneness

Metabolic Syndrome/Syndrome X
- Constellation of metabolic disorders
- Increase Risk Of cardiovascular disease
- Major features
  - Central Obesity
  - Hypertriglyceridemia
  - Low HDL
  - Hyperglycemia
  - Hypertension
**Metabolic syndrome**

- Estimated in 47 million US adults
- Identified by the presence of 3 or more of the following:
  - Elevated waist circumference (≥ 102 cm men or ≥ 88 cm women)
  - Elevated triglycerides (≥ 150 mg/dL or drug treatment)
  - Reduced HDL-C (< 40 mg/dL men, < 50 mg/dL women or drug treatment)
  - Elevated blood pressure (≥ 130 mm Hg systolic or ≥ 85 mm Hg diastolic or drug treatment)
  - Elevated fasting glucose (≥ 100 mg/dL or drug treatment)


**Prevalence of Metabolic syndrome**

- Increases with age
- Per National Health and Nutritional Examination Survey (NHANES) III
  - 34% Men
  - 35% Women
  - Native Americans
  - Nearly 60% women aged 45-49
  - 45% men aged 45-49

**Metabolic Syndrome & Inflammation**

- Proinflammatory cytokines increased
  - IL-1, IL-6, IL-18, resistin, TNF-α, CRP
  - Increased production by adipose tissue derived macrophages
- Adiponectin decreased
  - Anti-inflammatory cytokine/inhibits steps in inflammatory process
  - Enhances insulin sensitivity
  - In liver – enhances expression of gluconeogenic enzymes and glucose production
  - In muscle – increases glucose transport, enhances fatty acid oxidation

**Metabolic Syndrome/Associated diseases**

- Cardiovascular disease – 1.5-3X relative risk in absence of diabetes
- Type 2 Diabetes – 3-5X
- Nonalcoholic Fatty Liver Disease
- Hyperuricemia
- Obstructive Sleep Apnea

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**Central Morbid Obesity**

- Insulin Resistance
- Hyperinsulinemia
- Dyslipidemia
- Type 2 Diabetes
- Hypertension
- Heart Disease

Adapted from Lee YH, Pratley RE. The evolving role of inflammation in obesity and the metabolic syndrome. Curr Diab Rep. 2005; 5:70-75
Medical Therapy for Obesity

What Are Realistic Expectations?

An optimal and continuous program which uses
- Medications
- Behavior modification
- Diet
- Exercise

can be expected to achieve and maintain a weight loss of 20 pounds if continued permanently.

High Attrition Rates of Commercial Weight Reduction Programs

Comparison of Atkins®, Ornish, Weight Watchers®, and Zone Diets

- Randomized trial of 160 patients with average BMI of 35 (enrollment 2000 to 2002)
- Medically supervised
- Each diet reduced the LDL/HDL ratio by 10 percent

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<th>Type of Diet</th>
<th>Completing One Year</th>
<th>Weight Loss at One Year</th>
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<tr>
<td>Atkins®</td>
<td>21/40 (53%)</td>
<td>2.1 kg (4 lbs)</td>
</tr>
<tr>
<td>Zone</td>
<td>26/40 (65%)</td>
<td>3.2 kg (7 lbs)</td>
</tr>
<tr>
<td>Weight Watchers®</td>
<td>26/40 (65%)</td>
<td>3.0 kg (6 lbs)</td>
</tr>
<tr>
<td>Ornish</td>
<td>20/40 (50%)</td>
<td>3.3 kg (7 lbs)</td>
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Atkins is a registered trademark of Atkins Nutritionals, Inc.
Weight Watchers is a registered trademark of Weight Watchers International, Inc.

Very Low Calorie Diet +/- Behavioral Modification

According to the NIH 1993

- “Surgery is the most effective option in achieving sustained weight loss in the morbidly obese patient population.”
Roux-en Y Gastric Bypass

- Gastric pouch: 15-20 ml
  - Stomach holds less food
  - Induces feeling of satiety
  - Small opening in pouch
  - Gastric remnant not removed
  - Theoretically reversible, but very difficult

Gastric Bypass

**Advantages**
- Rapid initial weight loss
- Minimally invasive approach is possible
- Longer experience
- Minimal diet restrictions
- Dumping syndrome limits sugar intake
- Less follow-up required
- No foreign body implanted

**Disadvantages**
- Anatomy is altered
- More operative complications than with LAGB
- Nonadjustable
- Reported higher mortality rate than LAGB/Gastric Sleeve procedures
- Extremely difficult to reverse
- Possibility of stretching pouch

Laparoscopic Adjustable Gastric Band

- A silicone band is placed around the upper part of the stomach
  - A small pouch is created
  - Stomach holds less food
  - Induces feeling of satiety
  - OR time = 1 hour
  - Overnight hospital stay
  - Return to work in 1 week
  - Evaluated every 6-8 weeks for gradual tightening if necessary

**Advantages**
- Adjustable – customized per patient
- Least invasive option
- No anatomic changes
- Removable
- Lowest operative complication rate – rare leaks
- Low malnutrition risk
- Satiation-inducing procedure
- OR time = 1 hour or less
- Outpatient surgery sometimes possible

**Disadvantages**
- Slower initial weight loss than gastric bypass
- Regular follow-up critical for optimal results
- Compliance is critical
- Foreign body
- Less long-term follow-up than bypass in US patients
- Erosion, slippage, infection

Sleeve Gastrectomy

- No foreign body
- Weight loss comparable to other operations—gastric bypass, band
- No rearranging of intestines
- Disadvantage: NOT reversible—part of stomach permanently removed
- Not as good for patients with acid reflux/hiatal hernia
Long Term Results Gastric Bypass

Mean Percent Change in Weight during a 15-Year Period in the Control Group and the Surgery Group, According to the Method of Bariatric Surgery

Weight Loss of Various Treatments for Morbid Obesity

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<th>Excess Weight Loss</th>
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</thead>
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<tr>
<td>Lifestyle / Pharmacologic Treatments(^1) (\text{Laparoscopic Adjustable Gastric Banding}^2)</td>
<td>&lt;10%* (48)%</td>
</tr>
<tr>
<td>Sleeve Gastrectomy(^2)</td>
<td>55%</td>
</tr>
<tr>
<td>Gastric Bypass Surgery(^2)</td>
<td>62%</td>
</tr>
</tbody>
</table>

\(^{1}\) Average weight loss from baseline; meta analysis of various studies up to 4 years in length.

\(^{2}\) Buchwald H, Avidor Y, Braunwald E et al. Bariatric surgery: A review and meta-analysis. JAMA 2004; 292(14):1724-1737. Meta-analysis of studies with at least 30 days of follow-up, with the majority of follow-up at two years or less.


Appetite Control Hormones

- Important in metabolism, appetite, and satiety regulation.
- Hormones made by the cells in the stomach and intestines act on the brain.
- Regulate body weight by controlling appetite (ghrelin), satiety (PYY, CCK), and body metabolism (leptin, melanocortin).

Ghrelin

- Hormone secreted predominantly by gastric cells, upper intestine cells; recognized in 1999 as a mediator of growth-hormone release\(^4\)
- Increases an hour or two before a meal and goes into a “trough-like” level after eating\(^5\)
- Weight loss of 17 percent of body weight from dieting is associated with a 24 percent increase in the 24-hour ghrelin profile\(^6\)
- Weight loss of 36 percent of body weight following gastric bypass surgery resulted in a 77 percent decrease in ghrelin levels from normal-weight controls and a 72 percent decrease in matched obese controls\(^7\)
- Activated by the presence of dietary lipids


Peptide YY

- Released by intestinal endocrine L-Cells of distal gut
- Released in proportion to calories ingested
- Inhibits gastric, pancreatic and intestinal secretions and gastric motility
- Promotes satiety
- Increased secretion following malabsorptive procedures
- Roux-en-Y and BPD
- Probably from gut hypertrophy (weight regain?)
Leptin/CCK

- Cholecystokinin (CCK)
  - Inhibits gastric motility
  - induces feeling of satiety
  - Not affected by surgery
- Leptin
  - Released by adipose tissue
  - As fat stores rise – leptin rises, signaling we have enough to eat
  - Obese people have high leptin levels – Resistance to their actions
  - Levels fall after surgery – Increasing satiety, decreasing hunger

Melanocortin

- Melanocortin-4 receptor gene (MC4R) variants are associated with obesity and binge eating disorder (BED)
- 300 patients (233 women, 67 men) with a mean BMI of 43.5 and a mean age of 42
- Laparoscopic Adjustable Gastric Banding
- 36-month follow-up
- All MC4R patients had BED, compared to 18 percent in non-carriers
- MC4R patients showed less weight loss and five times more gastric complications

Other Appetite Control Hormones

- GLP-1
  - Secreted by lower intestinal endocrine L cells to induce satiety
  - Glucoregulatory – Impacts glycemic control by inhibiting glucose dependent inhibition of glucagon secretion
  - Slows gastric emptying
- Entero glucagon Family (GLP-1, GLP-2, oxyntomodulin)
  - Dual intestinal L cell secretion
  - Iv infusions decrease hunger and caloric intake
  - Increased in dumping syndrome
- Glucose-dependent Insulinotropic polypeptide (GIP)
  - Secreted within minutes of nutrient ingestion
  - Promotes energy storage by inducing beta proliferation

Other Appetite Control Hormones

- Pancreatic Polypeptide
  - Released by pancreas in response to food intake
  - Decreases food intake and gastric emptying
  - Increases energy expenditure – Helps create negative energy balance
  - Decreases Leptin production in adipose cells
- Glucose-dependent Insulinotropic polypeptide (GIP)
  - Secreted within minutes of nutrient ingestion
  - Promotes energy storage by inducing beta proliferation
  - Promotes increased bone formation through osteoblast formation

Government Agencies and Scientific Societies that Endorse Bariatric Surgery As A Standard of Care for Severe Obesity

Centers For Medicare and Medicaid Services
National Institute of Health
US Department of Veteran Affairs
US Department of Defense
The Obesity Society
American College Of Physicians
American Diabetes Association
American Dietetic Association
American Association of Clinical Endocrinology
Association for Metabolic and Bariatric Surgery
American College of Surgeons
Society for Surgery of the Alimentary Tract
Society of American Gastrointestinal and Endoscopic Surgeons

BARIATRIC SURGERY

Losing 50% to 70% of excess weight may be just the beginning… Resolution of Comorbidities after Bariatric Surgery

- Quality of Life improved
- Mortality reduced
- Mortality reduced
- Mortality reduced
- Mortality reduced
- Mortality reduced

Surgery and Diabetes/Insulin Resistance

- Decrease in Fat mass with weight loss
- All procedures
  - Roux-en-Y bypass most studies and accepted as “best” treatment for diabetes
  - Sleeve gastrectomy newer but studies suggest it does as well
- Anti-inflammatory factor adiponectin increased post surgery
  - Favorably impacts insulin resistance
  - Helps remission/improvement of diabetic state

Why Risk Bariatric Surgery?

Journal

Title: Why would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus

Authors: Pories WJ, Swanson MS, MacDonald KG

Y;vol:pp 1995;222:339-350

Key point: Surgery is more effective than medical therapy in treating obesity related diabetes

Impact of Bariatric Surgery on Diabetes

Impact of All Surgery Types and Gastric Bypass, in Specific on Diabetes

<table>
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<tr>
<th>Condition</th>
<th>% Resolved</th>
<th>% Improved</th>
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<tbody>
<tr>
<td>Diabetes</td>
<td>76.8</td>
<td>85.4</td>
</tr>
<tr>
<td>Hypertension</td>
<td>61.7</td>
<td>78.5</td>
</tr>
<tr>
<td>Sleep Apnea</td>
<td>83.6</td>
<td>85.7</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>70</td>
<td>96.9</td>
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Effect of Bariatric Surgery on Comorbid Medical Conditions

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Impact of All Surgery Types and Gastric Bypass on Hypertension

<table>
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<tr>
<th>Outcome</th>
<th>TOTAL</th>
<th>GASTRIC BYPASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients Hypertension Resolved</td>
<td>67 (6.62)</td>
<td>67.1 (64.7)</td>
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HYPERTENSION IS RESOLVED OR IMPROVED IN MOST PATIENTS FOLLOWING BARIATRIC SURGERY

Surgery and Diabetes/Insulin Resistance

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Sleeve Vs. Roux-En-Y

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<th>Sleeve Gastrectomy</th>
<th>Roux En Y Bypass</th>
</tr>
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<tbody>
<tr>
<td>Total Cholesterol</td>
<td>75%</td>
<td>100%</td>
</tr>
<tr>
<td>Resolution of Hypertension</td>
<td>64.3%</td>
<td>74.4%</td>
</tr>
<tr>
<td>Remission of Diabetes</td>
<td>96%</td>
<td>85.7%</td>
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Methods: Study Design

- Observational two-cohort study
- Subjects: 1,035 morbidly obese patients treated with bariatric surgery at the McGill University Health Centre, Montreal
- Controls
  - 5,746 matched morbidly obese patients who had not undergone surgery
  - Controls matched for age, BMI, date of first diagnosis of M/O, gender, and disease status
  - Inception time for bariatric cohort was surgery date.
  - Inception time for controls was date of surgery of their match


Impact of Bariatric Surgery on Hyperlipidemia

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<tr>
<td>% Patients Improved</td>
<td></td>
<td></td>
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<tr>
<td>Hyperlipidemia</td>
<td>23 (846/1,019)</td>
<td>79.3 [68.2, 90.5]</td>
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<td>HDL Gastroplasty</td>
<td>14 (2,051)</td>
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<td>21 (879)</td>
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<td>Triglycerides</td>
<td>34 (2,149)</td>
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Baseline Cohorts

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<tr>
<td>Number of Subjects</td>
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<td>5,746</td>
</tr>
<tr>
<td>Mean Age (SD)</td>
<td>45.1 (11.6)</td>
<td>46.7 (13.1)</td>
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<td>Male Gender N (%)</td>
<td>356 (34.4%)</td>
<td>2,068 (36.0%)</td>
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HYPERLIPIDEMIA AND HYPERCHOLESTEROLEMIA IMPROVE IN MOST PATIENTS FOLLOWING BARIATRIC SURGERY

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Significant Relative Risk Reduction in Morbidity and Mortality at Five Years

Reduction in Incidence of Co-morbidities at Five Years

* p < 0.001

5-Year Mortality Reduction

Surgical Patients had Nine Times Lower Mortality Rate within the Study Period

* Includes perioperative (30-day) mortality of 0.4% p-value 0.001

Reduction in Healthcare Utilization

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<th>CONTROLS MEAN (SD)</th>
<th>P-VALUE</th>
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<tr>
<td>Hospitalizations</td>
<td>2.75 (3.44)</td>
<td>3.17 (3.22)</td>
<td>0.001</td>
</tr>
<tr>
<td>Hospital Days</td>
<td>21.05 (38.97)</td>
<td>36.59 (25.41)</td>
<td>0.001</td>
</tr>
<tr>
<td>Physician Visits</td>
<td>9.62 (15.8)</td>
<td>17.00 (21.74)</td>
<td>0.001</td>
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Summary

- Similar to the above study, there are multiple others demonstrating that bariatric surgery is safe with a lower mortality rate than the general morbidly obese population.
- Bariatric surgery patients have a lower mortality rate in the long-term follow-up.
- Bariatric surgery patients have significant risk reductions for developing all major categories of chronic, inflammatory conditions.
- Surgery patients had significantly fewer hospitalizations, in-hospital days, and outpatient physician visits.
- Direct healthcare costs are significantly lower in the surgery cohort with surgical costs recovered within 2 years.