Current Trends in the Surgical Treatment of Obesity and Metabolic Disease – A Transplant Perspective

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Disclosures

- Medtronic: Consultant / Advisor
- Olympus: Consultant
- Intuitive Surgical: Case Proctor
The shape of things to come
What is Obesity?

- Obesity is a disease of excess accumulation of body fat.
- It is a poorly understood chronic disease caused by multiple factors.
Obesity Trends* Among U.S. Adults

(*BMI ≥30, or about 30 lbs. overweight for 5’4” person)
Prevalence of Self-Reported Obesity Among U.S. Adults by Race/Ethnicity, State and Territory, BRFSS, 2012-2014

Method

- The data were collected through the Behavioral Risk Factor Surveillance System (BRFSS), an ongoing, state-based, telephone interview survey conducted by state health departments with assistance from CDC.

- Height and weight data used in the BMI calculations were self-reported.

- Three years of data were combined to ensure sufficient sample size.
Prevalence of Self-Reported Obesity Among U.S. Adults by Race/Ethnicity, State and Territory, BRFSS, 2012-2014

Exclusion Criteria

Records with the following were excluded:

- Height: <3 feet or ≥8 feet
- Weight: <50 pounds or ≥650 pounds
- BMI: <12 kg/m² or ≥100 kg/m²
- Pregnant women
Prevalence of Self-Reported Obesity Among Non-Hispanic White Adults, by State and Territory, BRFSS, 2012-2014

*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.
Prevalence of Self-Reported Obesity Among Non-Hispanic Black Adults, by State and Territory, BRFSS, 2012-2014

*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.
Prevalence of Self-Reported Obesity Among Hispanic Adults, by State and Territory, BRFSS, 2012-2014

*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.
Prevalence* of Self-Reported Obesity Among U.S. Adults
BRFSS, 2012

*Prevalence reflects BRFSS methodological changes in 2011, and these estimates should not be compared to those before 2011.
Prevalence\(^1\) of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2013

\(^1\) Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.

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Prevalence\(^\d\) of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2014

\(^\d\) Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.

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Prevalence\textsuperscript{1} of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2016

\textsuperscript{1} Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.

*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥ 30%.
CONNECTICUT
Obesity Fact Sheet

ADULT OBESITY FACTS:

- Obesity affects more than 25.3% of Connecticut residents.
- More than 27.2% of men and 24% of women are affected by obesity.
- Connecticut is ranked 42/51 in states impacted by obesity.
- The age group most affected by obesity in Connecticut is 45-64 (29.2%).
- Connecticut ranks 31st in adults with Type 2 Diabetes (9.3%).

CHILDHOOD OBESITY FACTS:

- Connecticut is one of only 12 states that has a physical activity requirement in their schools.
- 12.3% of high school students are affected by obesity.
- Connecticut is NOT one of the 19 states that have BMI screening requirements.

NATIONAL COST OF OBESITY

- $315.8 BILLION: Estimated cost of annual obesity-related healthcare.
- 42%: How much more healthcare costs for individuals affected by obesity.
- $14.1 BILLION: The direct costs caused by childhood obesity.
- $4.3 BILLION: Nationwide annual costs due to obesity-related absenteeism.

References:
- Centers for Disease Control
- Trust for America’s Health
- Obesity Action Coalition

Questions?
If you have any questions regarding the above information or if you would like to receive free educational materials on obesity, please contact the OAC National Office at (800) 717-3117 or info@obesityaction.org.

Obesity is a serious chronic condition that continues to have a growing impact on our society, and carries with it a large number of related conditions such as diabetes, hypertension, heart disease, and more. Action must be taken to address this epidemic at all levels — individual, family, community, government, healthcare and insurance. To learn more about the disease of obesity, treatment options, weight bias, and more, please visit the Obesity Action Coalition (OAC) Web site at www.ObesityAction.org.
Example: Life expectancy of a 20-year-old morbidly obese male is 13 years shorter than a normal-weight male of the same age.

NO MAGIC

Calories IN

WEIGHT GAIN!

Calories BURNED
Just 120 extra calories per day???
Mortality of Obesity

- Obesity worsens health and quality of life and shortens life expectancy

- Obesity in adulthood is associated with a decrease in life expectancy of about seven years in both men and women

- After smoking, obesity is the second-leading preventable cause of death in US
Obesity and Population Health Management

- This will probably be an important component of every health-care delivery system in the future.
- A service line in itself
- Large corporations (often self-insured, TPA) will be looking for VALUE via disease prevention
- Invest now (treat obesity)
- Financial rewards later (less obesity related diseases - DM / CKD / HTN / CAD)
- Plus, It’s the right thing to do…
EBOLA!!!

Obesity: 300,000 deaths per year

Tobacco: 450,000 deaths per year

Alcohol: 88,000 deaths per year

USA
Comorbidity Resolution: Hypertension

- RYGB Site, 75.7
- SG Site, 66.7
- AGB Site, 63.6
Comorbidity Resolution: Diabetes

- RYGB Site, 81%
- SG Site, 61.5%
- AGB Site, 75%

Graph showing percent resolution of diabetes over time (6mo, 1yr, 2yr) for RYGB Site, SG Site, and AGB Site, compared to national averages.
Comorbidity Resolution: Hyperlipidemia

RYGB Site, 91.7
SG Site, 66.7
AGB Site, 75

Percent Resolution

RYGB Site  SG Site  AGB Site  RYGB National  SG National  AGB National
Metabolic Surgery for Type 2 Diabetes: Changing the Landscape of Diabetes Care

William T. Cefalu¹, Francesco Rubino² and David E. Cummings³

Author Affiliations

Corresponding author: William T. Cefalu, cefaluwt@pbrc.edu.


Metabolic Surgery in the Treatment Algorithm for Type 2 Diabetes: A Joint Statement by International Diabetes Organizations

Francesco Rubino¹, David M. Nathan², Robert H. Eckel³, Philip R. Schauer⁴, K. George M.M. Alberti⁵, Paul Z. Zimmet⁶, Stefano Del Prato⁷, Linong Ji⁸, Shaukat M. Sadikot⁹, William H. Herman¹⁰, Stephanie A. Amiel¹, Lee M. Kaplan², Gaspar Taroncher-Oldenburg¹¹ and David E. Cummings¹² on behalf of the Delegates of the 2nd Diabetes Surgery Summit
Pharmacotherapy for Obesity: ENDO Society Guidelines

<table>
<thead>
<tr>
<th>Drug</th>
<th>Mechanism of Action</th>
<th>Mean Weight Loss</th>
<th>Study Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phentermine resin</td>
<td>Norepinephrine-releasing agent</td>
<td>3.6 kg</td>
<td>2 to 24 weeks</td>
</tr>
<tr>
<td>Diethylpropion</td>
<td>Norepinephrine-releasing agents</td>
<td>3.0 kg</td>
<td>6 to 52 weeks</td>
</tr>
<tr>
<td>Orlistat</td>
<td>Pancreatic and gastric lipase inhibitor</td>
<td>2.9 to 3.4 kg, 2.9% to 3.4%</td>
<td>1 year</td>
</tr>
<tr>
<td>Lorcaner</td>
<td>5HT2c receptor agonist</td>
<td>3.6 kg, 3.6%</td>
<td>1 year</td>
</tr>
<tr>
<td>Phentermine/topiramate</td>
<td>GABA receptor modulation (topiramate) plus norepinephrine-releasing agent (phentermine)</td>
<td>6.6 kg (recommended dose), 6.6%; 8.6 kg (high dose), 8.6%</td>
<td>1 year</td>
</tr>
<tr>
<td>Naltrexone bupropion</td>
<td>Reuptake inhibitor of dopamine and norepinephrine (bupropion) and opioid antagonist (naltrexone)</td>
<td>4.8%</td>
<td>1 year</td>
</tr>
<tr>
<td>Liraglutide</td>
<td>GLP-1 agonist</td>
<td>5.8 kg</td>
<td>1 year</td>
</tr>
</tbody>
</table>

over placebo.

GABA: gamma-aminobutyric acid; GLP-1: glucagon-like peptide-1.

**ENDO Society Guidelines: common side effects**

**Key Point: Side Effects Guide Treatment**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Common Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phentermine resin</td>
<td>Headache, elevated BP, elevated heart rate, insomnia, dry mouth, constipation, anxiety, palpitation, tachycardia,</td>
</tr>
<tr>
<td>Diethylpropion</td>
<td>Decreased absorption of fat-soluble vitamins, steatorrhea, oily spotting, fecal urgency, oily evacuation, increased defecation</td>
</tr>
<tr>
<td>Orlistat</td>
<td>Headache, nausea, dry mouth, dizziness, fatigue, constipation</td>
</tr>
<tr>
<td>Lorcanerin</td>
<td>Insomnia, dry mouth, constipation, paresthesia, dizziness, dysgeusia</td>
</tr>
<tr>
<td>Phentermine/topiramate</td>
<td>Nausea, constipation, headache, vomiting, dizziness</td>
</tr>
<tr>
<td>Naltrexone bupropion</td>
<td>Nausea, vomiting</td>
</tr>
<tr>
<td>Liraglutide</td>
<td>Nausea, vomiting</td>
</tr>
</tbody>
</table>

Saturation theory of Obesity

- Obesity is a disease of inflammatory mediators
- Liver and Omentum act as inflammatory “sponge”
- Saturation
- Rapid Emergence of metabolic syndrome disease
NIH Indications for Surgery

• Morbid Obesity: BMI > 40 kg/m\(^2\)
  100 lbs over ideal weight

• BMI > 35 kg/m\(^2\) + high risk comorbidity (obesity-related cardiomyopathy, DM, sleep apnea) or impaired lifestyle (limited employment, ambulation, family function)

• Documented repeated failure to control weight with medical means

NIH Consensus Panel, 1991
Who Qualifies for Weight-Loss Surgery?

BMI Used to Describe Various Levels of Body Fat

- **Normal Weight** (BMI 18.5 to 24.9)
- **Overweight** (BMI 25 to 29.9)
- **Obese** (BMI 30 to 34.9)
- **Severely Obese** (BMI 35 to 39.9)
- **Morbidly Obese** (BMI 40 or more)
Medical Co-morbidities

- Diabetes
- Hypertension
- Hyperlipidemia
- Hypercholesterolemia
- Obstructive Sleep apnea
- Cardiovascular disease
- Coronary artery disease
- Congestive heart failure
- Urinary stress incontinence
- Asthma/pulmonary disorder
- Gastroesophageal reflux disease (GERD)

- Degenerative joint disease (DJD)
- Osteoarthritis
- Gallstones
- Stroke
- Cancer
- Amenorrhea
- Polycystic ovary syndrome
- Infertility
- Menstrual irregularity
- Dysmenorrhea
- Depression
- Sexual dysfunction
Obesity Related Cancers

- Esophageal
- Colon
- Cervical
- Breast
- Prostate
- Ovarian
- Uterine

Herra 1999
Carrol 1998
Everhart 1993
NAFLD

- Prevalence on obesity is 80-90%
- Approximately 30% of morbidly obese bariatric patients have isolated portal fibrosis (Abrams and Clements)
- Has significant impact on safety of bariatric surgery
- High protein / low carbohydrate “glycogen sparing” diet prior to bariatric surgery to rapidly decrease size of left lobe of liver
48F, T2DM, hypercholesterolemia, lost 35 pounds before surgery, slightly elevated AST / ALT
Patient Profile

- More women than men (81% at HH)
- Ages 18-70+
- Often overweight since childhood
- Lifetime of discrimination
- Tried multiple (10+) diets and exercise
- Average two years of research into surgery
  - very educated and knowledgeable
Bariatric Surgery

- **Malabsorption**
  - Alters intake of nutrients
  - Duodenal Switch / SIPS / SADI

- **Restriction**
  - Alters amount of calorie intake
  - Laparoscopic Adjustable Gastric Banding
  - Sleeve Gastrectomy

- **Hybrid of restriction and malabsorption**
  - Roux-en-Y Gastric Bypass
Purely Restrictive Operations

- Restrict the amount of food that you can consume and therefore decrease the number of calories eaten.
- This type of procedures do not alter the digestive or absorptive function of the intestine

Malabsorptive Operations

- A large percentage of the small intestine is “bypassed” leading to decreased absorption of the food which is eaten, especially fats.
- Food passes through the body without being digested.
Restrictive Operations

- Vertical Banded Gastroplasty
- Adjustable Gastric Band
- Sleeve Gastrectomy
Laparoscopic Adjustable Gastric Band

When saline is placed into the fill port, it causes the balloon on the inside of the band to inflate, making it tighter on the stomach.
Sleeve Gastrectomy

Advantages
- Lower risk than gastric bypass
- Can be converted to gastric bypass
- Staged procedure in high risk patients
- Low malnutrition risk
- More weight loss than adjustable gastric band

Disadvantages
- Higher risk than adjustable gastric band
- Less weight loss than gastric bypass
- Non-reversible
- Lack of long-term follow-up data
Roux-en-Y gastric bypass
Mason (1967)

- 65% - 75% excess body weight loss
- Restriction and malabsorption
Duodenal Switch
Single Anastomosis Duodenal Switch
SADI, SIPS-DS
INTRAGASTRIC BALLOON

Designed according to “1987 Obesity Congress” criteria, as part of a comprehensive weight loss program:

- Spherical silicone balloon
- Smooth surface
- Saline filled
- Wide fill volume range
- Radiopaque marker
- 6 months duration
GREATER WEIGHT LOSS IN ORBERA™ GROUP THROUGH 12 MONTHS

ORBERA™ provided 3.1x weight loss vs. diet & exercise alone
Mean EWL at 6 months: 38%

mITT – Mixed Model / LOCF
INTRAGASTRIC BALLOON—INDICATION (US)

**ORBERA™ US Indication**

- **Overweight (BMI 27.5-30)**
- **Obesity (BMI ≥30 or ≤40)**
- **Morbid Obesity (BMI 40-50+)**

**OFF-LABEL IN THE US**

- ORBERA® Indication Outside US
- BIB® Indication Outside US - Primary / Bridge Procedure (EU, Brazil, Canada, Australia, etc)

**OFF-LABEL IN THE US**
Advantages

• No change in the GI anatomy
• EWL 25-35%
• It can be removed
• Reduction in hunger leads to weight loss that can be maintained
• No dietary restrictions
• Lower risk than other surgical options
• Rare complications (malfuction, injury to the nerves or surrounding structures)

Disadvantages

• No coverage by insurance currently
• Implantable device
• MRI incompatible
• Current battery life ~ 8 years
• Some patients can feel therapy
• 7% of patients may require a revisional surgery
• 4% will require explant due to intolerance
Bariatric Procedure Profile

- Vast majority of procedures (>98% performed laparoscopic (minimally invasive))
- Relatively short procedures (1-2.5 hrs)
- Short hospital length of stay (2.4 d LOS)
Bariatric Procedure Profile

- Minimally invasive advantages:
  - Excellent visualization
  - Early ambulation, short stays
  - Minimal (but still some) wound pain
  - Low risk of hernias and wound complications
  - Rapid return of bowel function
Postoperative Management Goals

- Early mobility (prevent DVT and PE)
- Early enteral clear liquid bariatric diet
- Minimize PONV
  - Vomiting can harm staple lines
  - Increases LOS
  - Leads to dehydration
  - Poor patient satisfaction
Meta-analysis

- 5 randomized trials
- 28 nonrandomized trials
- 101 uncontrolled case series of bariatric surgery.
- 20% were male and 80% were female
- Mortality (30 days)
  - 0.1% for purely restrictive procedures,
  - 0.5% for gastric bypass
  - 1.1% for biliopancreatic diversion or duodenal switch

Comorbidity Resolution Meta-analysis

- A Systematic Review and Meta-analysis
  - 22,094 patients; 136 studies
  - DM (15.3%), IGT (25.8%)

- Diabetes:
  - Completely resolved in 76.8%
  - Resolved or improved in 86%
  - Fasting Glucose change: -71.53 mg/dL
  - HbA$_{1C}$ change: -2.40%
  - Fasting Insulin change: -17.22 µU/ml

Survival

- Bariatric surgery group (N = 1035)
  - 81% RYGBP, 19% VBG
- Control group (N = 5746) age- and gender matched severely obese patients who had not undergone weight reduction surgery
- Follow-up: 5 years

Survival

Weight Loss After Roux-en-Y Gastric Bypass

100 pounds = 32% weight loss

# Diabetes Therapy: Drugs vs Surgery

<table>
<thead>
<tr>
<th>Title</th>
<th>Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Pories WJ, Swanson MS, MacDonald KG, et al</td>
</tr>
<tr>
<td></td>
<td>1995;222:339-350</td>
</tr>
<tr>
<td>Key point</td>
<td>Surgery is more effective than medical therapy in treating diabetes</td>
</tr>
</tbody>
</table>
Pories et al, 1995

- 608 morbidly obese patients
- 298 pts with adequate follow-up:
  - 82.9% w/ NIDDM and 98.7% w/glucose intolerance achieved and maintained normal levels of plasma glucose, insulin, and A1C

Medical comorbidities improve or resolve after bariatric surgery

- Diabetes
- Hypertension
- Hypercholesterolemia / Dyslipidemia
- Metabolic Syndrome
- Obstructive Sleep Apnea
- Exercise Tolerance
- Pulmonary Function
- Gastroesophageal Reflux Disease (GERD)
- Urinary Stress Incontinence
- Infertility / PCOS / Menstrual Irregularities
- Cardiac Function / Peripheral Edema
### Table 5. Efficacy for Improvement in Diabetes-Related Outcomes for All Patients

<table>
<thead>
<tr>
<th>Diabetes Course</th>
<th>Chemistry Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Population†</td>
</tr>
<tr>
<td>Resolved</td>
<td>Resolved or Improved</td>
</tr>
<tr>
<td>Patients evaluated</td>
<td>1846</td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td>76.8% (70.7% to 82.9%)</td>
</tr>
<tr>
<td>Gastric Banding</td>
<td>Patients evaluated</td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td>47.9% (29.1% to 66.7%)</td>
</tr>
<tr>
<td>Gastric Bypass†</td>
<td>Patients evaluated</td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td>83.7% (77.3% to 90.1%)</td>
</tr>
<tr>
<td>Biliopancreatic Diversion or Duodenal Switch</td>
<td>Patients evaluated</td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td>98.9% (96.8% to 100.0%)</td>
</tr>
</tbody>
</table>

Bariatric Surgery for Diabetes

- Resolution of diabetes occurs days after surgery with RYGB (not LAGB)
  - 1/3 within 3 days post-op; 2/3 within 1 month
  - 50% decline in plasma insulin on POD#6, long before substantial weight loss
- Weight loss alone cannot explain improvement

Bariatric Surgery and T2 DM

- Two prospective-randomized trials of bariatric surgery
- NEJM (March 2012)
- Bariatric Surgery is the most effective treatment for T2 DM in obese and morbidly obese
- Should be considered earlier and more often in patients with obesity and DM
STAMPEDE Trial

- STAMPEDE 3-year results (NEJM March 2014)
  - Randomized, controlled 3-arm trial
  - BMI 27-43 kg/m^2 (36% had BMI less than 35)
  - All diabetic patients

- Endpoint of HgA1C < 6.0%
  - 5% of medical group
  - 38% RYGB
  - 24% LSG group

- % Weight loss:
  - 4.2% medical
  - 24.5 RYGB
  - 21.1 LSG
- Greater percentage of weight loss at 2 years and lower baseline HbA1c values were independently associated with remission.
- Only 12% of pts who lost less than 10% of body weight were in remission at 2 years.
- Only 15% losing more than 10% body weight did not achieve remission.
Mechanisms

- Weight loss
- Decreased caloric intake
- Malabsorption
- Early delivery of nutrients to the distal small intestine
- Exclusion of the proximal intestine
Metabolic Effects of Bariatric Surgery

- Improved beta cell function
  - Reported severe hyperinsulinemic hypoglycemia

- Improved acute insulin response
  - ↓ intra-abdominal fat
  - ↓ Ghrelin (increased satiety)
  - ↓ IGF-1
  - ↓ FFA levels in BPD (↓ insulin resistance)
  - ↑ GLP-1, peptide YY (↑ satiety)
Vitamins / Minerals

- Multivitamin (folic acid)
- B-12 – especially with RYGB ( +/- sleeve)
  - Must be given parenteral (IM, SL, nasal)
- Calcium (watch Mg, K)
- Iron (may need infusion if poor absorption)
- Omega-3 Fatty Acids
- Thiamine and Folate
- Micronutrients (biotin, selenium)
### General supplementation recommendations

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Daily Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivitamin (contains folic acid)</td>
<td>One daily One to two daily Two daily</td>
</tr>
<tr>
<td>Calcium citrate with vitamin D₃</td>
<td>1200–1500mg/day 1800 mg/day</td>
</tr>
<tr>
<td>Vitamin D₃</td>
<td>consider 1000 IU/day 2000 IU/day</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>crystalline 500 µg/day oral or 1000 µg/month intramuscularly monitor and start if needed.</td>
</tr>
<tr>
<td>Elemental iron</td>
<td>65 mg elemental iron in menstruating females</td>
</tr>
<tr>
<td>Vitamin A, K</td>
<td>10,000 IU vitamin A and 300 µg/vitamin K</td>
</tr>
</tbody>
</table>

*Recommend in most cases that routine supplementation begin at discharge from hospital so that the patient develops a routine early. The author’s program begins a multi-vitamin supplement and B complex pre-operatively during preparatory weight-management phase in all patients, and adds 1000 IU vitamin D₃, if pre-operative vitamin D deficiency is found.*
Discussing bariatric surgery

Need to have the **courageous** conversation with your patient
Discussing Bariatric Surgery: options

- AVOIDANCE
- PREVENT
- INDIFFERENCE
- SUPPORT
Discussing Bariatric Surgery

- Support and Encourage weight loss:
  - Focus on goals:
    - Healthier and better quality of life
    - Less medications
    - Can keep up with the kids (grandchildren)
    - Live longer
  - High likelihood that patient will seek treatment

- Most patients report that they are referred by specialty practices (Orthopedic / Neurosurgery, OB/GYN, Cardiology, Endocrine, pulmonary) after very frank discussions of risk of obesity
Kidney Dialysis, Transplant and Obesity

Most transplant centers will not transplant patients with morbid obesity.
Risks and Rewards

- Organs are a scarce resource and therefore need to steward organs to best possible results.
- Obese patients can benefit significantly from transplantation.
- Currently, bariatric surgery has higher clinical and financial risks (hospital / surgeon / COE data) in the transplant population.
- We have obligation to be extremely selective.
- Undoubtedly, more research is needed in this subset of the transplant and obesity population.
INTRODUCTION

- Bariatric surgery has been performed safely in patients on hemodialysis or those waiting to receive a renal transplant.
- Morbidly obese patients with end-stage renal disease (ESRD) that undergo dialysis, or with other stages of chronic kidney disease (CKD), may be considered “high-risk” when being evaluated for bariatric surgery.
- While potential risks exist for “high-risk” bariatric patients, the clinical benefits of weight-reduction may outweigh such risks and may improve short- and long-term clinical outcomes. Additionally, the risk of renal allograft transplantation in the morbidly obese patient is not clearly delineated in the medical literature.
- We reviewed our experience with bariatric surgery in morbidly obese patients on dialysis or with CKD.

METHODS

- This was a retrospective review of our prospective bariatric database.
- Inclusion criteria for the study:
  • Patients with a diagnosis of CKD (Stage I-V)
  • Patients with a diagnosis of CKD (any stage) undergoing dialysis (hemodialysis or peritoneal dialysis)
  • Patients eligible for, or have undergone, renal transplant
- Collected data included:
  • Demographics
  • Weight loss
  • Renal function
  • Intraoperative/postoperative complications
- All surgeries were performed at a single institution by two qualified MIS surgeons at a bariatric surgery center of excellence. Either LAGB or LRYGBP procedures were performed.
- The study was approved by and in accordance with the Institutional Review Board at our institution.

RESULTS

- From November 2006 – November 2010, eight patients met study criteria and underwent bariatric weight loss procedures

<table>
<thead>
<tr>
<th>DEMOGRAPHICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bariatric procedure</td>
</tr>
<tr>
<td>Laparoscopic adjustable gastric band placement (LapBand System, Allergan, Irvine, CA, USA)</td>
</tr>
<tr>
<td>Laparoscopic Roux-en-Y gastric bypass</td>
</tr>
</tbody>
</table>

| Etiologies of renal dysfunction: |
| Diabetes mellitus or hypertension |
| Polycystic kidney disease |
| Focal segmental glomerulosclerosis |

| Dialysis (hemodialysis) |
| 25.0% (n=2) |

| Immunosuppression at the time of surgery |
| 37.5% (n=3) |

| Age (mean, years) |
| 50 (range, 37-67) |

| Gender |
| 7 females, 1 male |

| Preoperative BMI (mean, kg/m²) |
| 46.3 (range, 38.5-53) |

| Patients with history of renal transplant |
| 25% (n=2) |

POST-OPERATIVE

- At a mean follow up 25 months, patients achieved a mean 49.4% excess weight loss (range, 22-83%); mean decrease in BMI was 10.4 (range, 5-21)
- Mean creatinine decreased from 3.0 to 2.8 mg/dl while mean glomerular filtration rate increased from 29.7 to 37.6 ml/min/1.73 m²
- One patient developed thrombosis of her arteriovenous fistula that required revision
- One patient developed acute renal failure that resolved with hydration
- Two patients with CKD were able to be placed on the transplant list and one patient underwent successful renal transplant following LAGB

CONCLUSIONS

- In our cohort of patients with chronic kidney disease, renal function remained stable, or improved, following LAGB or LRYGBP.
- Weight loss was comparable to national trends.
- Though prudent caution should be taken, CKD and a history of renal transplant should not preclude necessary weight loss procedures, as bariatric surgeries may lead to improvement of renal function with minimal morbidity.
- Patients who are not candidates for renal transplant due to their obesity may become eligible following bariatric surgery.
- This small retrospective series demonstrates that bariatric surgery is safe and effective in patients with chronic kidney disease with or without dialysis, as well as patients that have undergone renal transplant. Further investigation with larger and longer term studies are necessary to further validate our findings.

REFERENCES

Inclusion Criteria

• This was a retrospective review of our prospective bariatric database.

• Inclusion criteria for the study:
  • Patients with a diagnosis of CKD (Stage I-V)
  • Patients with a diagnosis of CKD (any stage) undergoing dialysis (hemo- or peritoneal-dialysis)
  • Patients eligible for, or have undergone, renal transplant
# DEMOGRAPHICS

<table>
<thead>
<tr>
<th>Bariatric procedure</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscopic adjustable gastric band</td>
<td>75.0%</td>
<td>(n=6)</td>
</tr>
<tr>
<td>Laparoscopic RYGBP</td>
<td>25.0%</td>
<td>(n=2)</td>
</tr>
</tbody>
</table>

| Age (mean, years)                           | 50     | (range, 37-67) |

| Gender                                      | 7 females, 1 male |

| Preoperative BMI (mean, kg/m²)              | 46.3    | (range, 38-53) |
## RENAL DISEASE

### Etiologies of renal dysfunction:
- **Diabetes mellitus or hypertension**: 62.5% (n=5)
- **Polycystic kidney disease**: 25.0% (n=2)
- **FSGS**: 12.5% (n=1)

### Additional Factors:
- **Dialysis (hemodialysis)**: 25.0% (n=2)
- **Immunosuppression at the time of surgery**: 37.5% (n=3)
- **Patients with history of renal transplant**: 25.0% (n=2)
Results

- At a mean follow up 25 months, patients achieved a mean 49.4% excess weight loss (range, 22-83%); mean decrease in BMI was 10.4 (range, 5-21)

- Mean creatinine decreased from 3.0 to 2.8 mg/dl while mean glomerular filtration rate increased from 29.7 to 37.6 ml/min/1.73 m²
Results

• One patient developed thrombosis of her arteriovenous fistula that required revision

• One patient developed acute renal failure that resolved with hydration

• Two patients with CKD were able to be placed on the transplant list and one patient underwent successful renal transplant following LAGB
Conclusions

- In our cohort of patients with chronic kidney disease, renal function remained stable, or improved, following LAGB or LRYGB.

- Weight loss was comparable to national trends
Conclusions

- Though prudent caution should be taken, CKD and a history of renal transplant should not preclude weight loss procedures, as bariatric surgeries may lead to improvement of renal function with minimal morbidity.

- Patients who are not candidates for renal transplant due to their obesity may become eligible following bariatric surgery.
# Renal Function and Bariatric Surgery


| Author      | Population | Type of surgery | Follow-up (week) | Baseline BMI (kg/m²) | Baseline wt (kg) | ΔBMI (kg/m²) | Δwt (kg) | ΔGFR (ml/min) | ΔRPF (ml/min) | ΔPU (g/24 h) | ΔAU (mg/24 h) | ΔCr (µmol/L) | ΔCrCl (ml/min) | ΔUrine P/C |
|-------------|------------|-----------------|------------------|----------------------|-----------------|-------------|---------|-------------|--------------|-------------|--------------|-------------|----------------|-------------|-------------|
| Serra       | 70         | RYGB            | 52               | 53                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Navarro-Diaz| 61         | RYGB            | 104              | 54                   | 151             | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Agrawal     | 94         | RYGB            | 52               | --                   | 134             | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Saliba      | 35         | RYGB            | 52               | 57                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Renal impairment |       |                 |                  |                      |                |            |         |              |               |             |             |             |               |             |
| Chagnac     | 8          | VBG             | 52               | 48                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Izzedine    | 1          | LRYGB           | 116              | 48                   | 127             | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Cuda        | 1          | LRYGB           | 56               | 36                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Soto        | 1          | LRYGB           | 230              | 85                   | 239             | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Tafti       | 1          | RRYGB           | 40               | --                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Agnani      | 1          | N/S             | 34               | 46                   | --              | --          | --      | --           | --           | --          | --           | --          | --            | --          |
| Fowler      | 1          | LRYGB           | 60               | 57                   | 150             | --          | --      | --           | --           | --          | --           | --          | --            | --          |

**Table 1**: Cumulative table of renal function parameters following bariatric surgery.

Renal Function and Bariatric Surgery

- In patients with normal pre-existing kidney function
  - greatest improvement in patients with diabetes and metabolic syndrome as opposed to simple morbid obesity
  - less effect with purely restrictive operations

- In patients with established kidney disease
  - small series and case reports alone
  - potent effect of RYGB
  - prospective studies would evaluate the ability of all forms of bariatric surgery to reverse renal decline in obese kidney disease patients

Paradoxical effect:

- In a study of 418,055 dialysis patients, high BMI (up to 37) had increased survival over 2-year average follow-up.

- Higher BMI patients had better nutrition?

# Bariatric Surgery Results in Kidney Transplantation

## Table 2

Published clinical studies of laparoscopic bariatric surgery in kidney transplantation

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Type of operation</th>
<th>n</th>
<th>CKD stage</th>
<th>Weight loss achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeman (2015)</td>
<td>LSG</td>
<td>52</td>
<td>V (47); IV (5)</td>
<td>Mean ΔBMI = -6.7 kg/m², mean %EBWL = 29.8 %; %BMI &lt; 35 = 55.8 %</td>
</tr>
<tr>
<td>Tariq (2013)</td>
<td>LGB</td>
<td>7</td>
<td>V</td>
<td>↓BMI &lt; 35 at 6 months in 100 % cohort</td>
</tr>
<tr>
<td>Lin (2013)</td>
<td>LSG</td>
<td>6</td>
<td>V (5); IV (1)</td>
<td>Mean EBWL = 50 % at 12 months*</td>
</tr>
<tr>
<td>Proczko (2013)</td>
<td>LGB</td>
<td>3</td>
<td>V</td>
<td>Mean ΔBMI = -8.7 kg/m² at 3 months</td>
</tr>
<tr>
<td>MacLaughlin (2012)</td>
<td>LSG</td>
<td>9</td>
<td>V (5)</td>
<td>Median EBWL = 43 %; median ΔBMI = -8.4 kg/m² at 6 months</td>
</tr>
<tr>
<td>Takata (2008)</td>
<td>LGB</td>
<td>7</td>
<td>V</td>
<td>Mean EBWL 61 % at 9 months</td>
</tr>
<tr>
<td>MacLaughlin RCT (2014)</td>
<td>LSG vs. BMC</td>
<td>5 vs. 6</td>
<td>III/IV</td>
<td>Mean ΔBMI: -12.0 vs -1.2 kg/m² at 12 months</td>
</tr>
<tr>
<td>Golomb (2014)</td>
<td>LSG</td>
<td>10</td>
<td>Post-transplant</td>
<td>Mean EBWL = 75 % at 12 months</td>
</tr>
<tr>
<td>Szomstein (2010)</td>
<td>LGB/LSG</td>
<td>4/1</td>
<td>Post-transplant</td>
<td>EBWL &gt; 50 % at 2 years in 100 % of cohort</td>
</tr>
<tr>
<td>Arias (2010)</td>
<td>LGB</td>
<td>5</td>
<td>Post-transplant</td>
<td>Mean ΔBMI = -11 kg/m²</td>
</tr>
</tbody>
</table>

*mean includes chronic liver failure patients

(CKD chronic kidney disease; LGB laparoscopic gastric bypass; LSG laparoscopic sleeve gastrectomy; BMI body mass index; EBWL excess body weight loss; RCT randomized clinical trial; BMC best medical care)
52 obese renal transplant patients (24% male)
Mean age: 50, BMI: 43
Renal failure etiology:
  - HTN 43%
  - DM 40%
  - FSGS 5%, ATN 3%, IgA nephropathy 3%
All patients had 6m medical weight management before LSG
Mean follow-up 220 (26-733) days
Mean %EWL: 32.1 (6.7-93.8)%
Mean %EWL prior to LSG: 3.6% - no patients able to achieve BMI targets
- No perioperative deaths
- 2 patients died (3.8%) first year
- 7% historic waitlist annual mortality rate
- 6 / 52 were transplanted
  - 3 LRD allografts
    - Mean time to transplant 415 (208-535) days
  - 3 deceased donor allografts
    - Mean time to transplant 164 (140-213) days
Kidney Dialysis, Transplant and Obesity

- Data from the United States Renal Data System database between 1988-1997 involving 51,927 adult transplant recipients.
  - RR for graft loss was 1.4 in patients with a BMI >36
  - RR for death censored graft loss (graft loss not including patients who die with functioning grafts = 1.45 for BMI > 36
  - Death with a functioning graft (RR = 1.36)
  - Cardiovascular-related complications (RR = 1.4)
  - The best overall results: patients with a BMI 22–24
  - Obese patients have a higher incidence of wound complications and delayed graft function

Kidney Dialysis, Transplant and Obesity

- El-Agroudy et al. compared obese transplant patients (BMI >30) to nonobese patients.

- Obese group had decreased graft and overall survival at 10 years after transplant (58% living with functioning graft vs. 72% for normal weight patients)

Kidney Dialysis, Transplant and Obesity

- Cacciola et al. compared patients with BMI 30–34.9 with patients of BMI 35 or greater who underwent renal transplant.

- The patient survival at 5 years for the lower BMI group was 95% and for the higher BMI group was 79%.

- Graft survival at 5 years was 94.5% for the lower BMI group and 63% for the higher BMI group.

Kidney Dialysis, Transplant and Obesity

- Takata et al. described LRYGB in 7 ESRD patients without perioperative complications or death.
- At 15 months follow-up, EBWL: 61% and all were listed for transplant.

Kidney Dialysis, Transplant and Obesity

- Reviewing the USRDS (2001–2004), Modanlou et al. identified 72 bariatric surgery cases performed pre-listing for transplant and 29 cases on the transplantation waitlist.
- Comparable EBWL: 60% but higher post-BS mortality (3.5%) compared to published series
- 20/29 bariatric pts proceeded to transplantation, with a median waiting time of 17 months.
- It is unlikely they would have been transplanted without their bariatric surgery.

### Outcomes of Laparoscopic Bariatric Surgery after Renal Transplant

<table>
<thead>
<tr>
<th>Case</th>
<th>BMI Pre</th>
<th>BMI Post</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>57</td>
<td>32</td>
<td>RYGBP</td>
</tr>
<tr>
<td>Case 2</td>
<td>44</td>
<td>30</td>
<td>RYGBP</td>
</tr>
<tr>
<td>Case 3</td>
<td>45</td>
<td>30</td>
<td>RYGBP</td>
</tr>
<tr>
<td>Case 4</td>
<td>69</td>
<td>32</td>
<td>RYGBP</td>
</tr>
<tr>
<td>Case 4</td>
<td>48</td>
<td>31</td>
<td>Aborted RYGBP, sleeve</td>
</tr>
</tbody>
</table>

Kidney Dialysis, Transplant and Obesity

- Rogers et al. conducted a pharmacokinetic study looking at the impact of RYGB on cellcept, tacrolimus, and sirolimus dosing in renal transplant recipients.

- They found a need to increase dosage to maintain a satisfactory level, indicating that extra vigilance may be required in immunosuppressive therapy in post-bariatric surgery renal transplant recipients.

Immunosuppression and Bariatric Surgery

- ACS-NSQIP database query
- 1277 Steroid / Immunosuppressant Dependent and 112,892 Non-Dependent patients
- 30d mortality rate OR=6.85, major morbidity OR=2.21
- Not procedure dependant

Liver Transplantation and Bariatric Surgery

- What is the optimal timing of surgery?
  - Pre LT
  - Simultaneous LSG / LT
  - Post LT

- What surgical approach is the most effective?
  - Unique risks and challenges at each phase
Pre-Liver Transplant

- Takata et al. described LSG in 6 patients with cirrhosis
- 33% EWL, 2 of 6 had complications, no deaths.
- No clear data on transplantation rates

Simultaneous LT/LSG

- All BMI >35
- 37 achieved weight loss, LT alone
  - 21/34 regained weight to BMI>35
  - 3 graft losses / 3 deaths
  - 12/34 had post LT DM, 7/34 had steatosis
- 7 LT+LSG
  - No deaths, no graft loss, one leak, one excessive weight loss
  - No DM or Steatosis, all with BMI <29

Liver Transplantation and Bariatric Surgery

- Sleeve gastrectomy on 9 pts with prior liver transplants
  - Laparoscopic (n=8)
  - Open (n=1)

- Mean operative time: 165 min and LOS 5 days.

- Complications
  - mesh dehiscence (conc. incisional hernia repair)
  - bile leak from the liver surface requiring lap drainage
  - postoperative dysphagia that required reoperation.

Liver Transplantation and Bariatric Surgery

- Calcineurin inhibitor levels and hepatic and renal functions remained stable.
- No episodes of graft rejection.
- At 3 months liver function tests remained stable.
- Excess weight loss averaged 55.5% at 6 months

Liver Transplantation and Bariatric Surgery

- Sleeve gastrectomy technically feasible after liver transplantation and resulted in weight loss without adversely affecting graft function and immunosuppression.

- Early complications may be more frequent as a result of adhesions of the left upper quadrant.

Bariatric Surgery and Heart Transplant

- Again a question of timing
- We have done surgery on post heart transplant patients with good results. Minimal impact on surgery
- Technical challenges preoperative
- Can safely do surgery in CHF
- +/- LVAD?