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Govern well thy appetite, lest Sin surprise thee, and her black attendant, Death.
—John Milton

Worldwide, we have just over 1 billion individuals starving to death.¹ We also have slightly more than 1 billion overweight individuals globally, 300 million of whom are considered obese.² With growing waistlines come a heavily compromised quality of life, critical illnesses, and in the worst of cases, fatality.

Those on this side of the spectrum are, arguably, eating themselves to death.

Nationwide, data show obesity rates are rising in 31 states,² and other parts of the developed world do not seem far behind with their own numbers. Obesity statistics in many European countries have tripled since the 1980s,³ and 23% of the Canadian population is obese.⁴

There are many postulations to explain the fat phenomenon, most pointing to “supersized” meals luring today’s value-hungry urban, sedentary consumers into the plethora of chain restaurants that are steadily sprouting up—to say nothing of genetics and psychology.

With obesity rates mounting and the demand for weight-loss surgery rising with them, General Surgery News felt there was a need for a journal that would bring the entire obesity care team up-to-date and clinically relevant reviews in an easy-to-reference format. We have consistently brought our readers cutting-edge information on all things surgery, and we were confident in our ability to deliver this publication as well.

So, with the tremendous support and guidance of Raul J. Rosenthal, MD, medical director of The Bariatric Institute and section head of minimally invasive surgery of Cleveland Clinic Florida, Weston, General Surgery News very proudly presents Obesity Care Special Edition.

The following 10 chapters address many areas of the bariatric therapy spectrum—among them coding and reimbursement, nutrition, psychology, and of course, surgery—all authored by highly esteemed key opinion leaders in their respective fields.

Beginning with a compelling review on surgery as obesity’s only effective treatment, this issue of Obesity Care Special Edition walks the reader through the bariatric surgery experience, from patient selection and preoperative assessment, to plastic surgery after rapid postoperative weight loss, to a look at future options for surgically treating this pandemic disease. Each chapter is available on generalsurgerynews.com, ready to print or e-mail to a colleague.

I welcome your feedback on our first special edition and your thoughts on what you would like to read in our next. Please send your letters to ekagan@mcmahonmed.com.

Warm regards,

Erica B. Kagan
Managing Editor
Obesity Care Special Edition

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Is Morbid Obesity a Surgical Disease?

HENRY BUCHWALD, MD, PhD
Owen H. and Sarah Davidson Wangensteen Chair in Experimental Surgery Emeritus, Professor of Surgery and Biomedical Engineering, University of Minnesota, Minneapolis, Minnesota

As the global epidemic of morbid obesity grows, so too does the number of bariatric operations performed. To date, surgical therapy is the only effective tool to combat the disease of morbid obesity.

Therapeutic Progression

Quite often in the treatment of a disease, there is progression from no effective therapy to surgical management to nonsurgical solutions initiated by surgeons themselves, industry, and medical practitioners. The critical turning point from no effective therapy to demonstration that effective therapy is feasible has frequently been brought about by surgeons who, by their nature, abhor a vacuum of patient care and find it difficult to accept a status quo of ineffectuality.

So was the case with peptic ulcer disease. As recently as 50 years ago, peptic ulcers were unsuccessfully treated by diets of atherogenic milk and cream and the admonition to adopt a less stressful lifestyle. Surgeons using subtotal gastrectomy, truncal vagotomy and antrectomy, truncal vagotomy and pyloroplasty, selective vagotomy, and super-selective vagotomy brought ulcer disease under control. Still, without a true understanding of mechanisms, ulcer therapy was taken over by industry and nonsurgical practitioners advocating H2 suppressors and then proton-pump inhibitors. It was not until 1993 that the etiology of most peptic ulcers was definitively related to a specific pathogen—Helicobacter pylori—and simple management by antibiotic therapy became the standard of care.

A similar tale is in progress with atherosclerotic cardiovascular disease. Fifty years ago, acute myocardial infarction was treated with 2 weeks of absolute bed rest; the underlying coronary disease was not treated at all. Then came the elucidation of the atherosclerosis risk factors of hyperlipidemia, hypertension, cigarette smoking, and diabetes. Yet the primary risk factor of hypercholesterolemia was, at best, poorly managed by diet and ineffectual drugs. The partial ileal bypass operation and the Program on the Surgical Control of the Hyperlipidemias (POSCH) trial first demonstrated that marked cholesterol reduction can be achieved, and that such reduction would result in a significant decrease in the incidence of myocardial infarction, peripheral vascular disease, the need for coronary artery bypass grafting or percutaneous transluminal coronary angioplasty, stabilization and actual regression of arteriographic disease, and finally, an increase in life expectancy. The active clinical use of partial ileal bypass was instructive and ground-breaking, but...
very brief with the advent of nonsurgical statin drug availability. Today’s emergent therapy for a coronary occlusion by arteriography, open heart surgery, or angioplasty represents another transition from no effective therapy to effective interventional therapy en route to effective noninterventional therapy, which has yet to come.

With respect to morbid obesity, there is still no effective nonsurgical therapy. Because surgical therapy is highly effective, morbid obesity is, at present, a surgical disease.

To address the global obesity epidemic, surgeons have devised procedures to treat the most afflicted individuals. When the next therapeutic innovation in obesity therapy—superceding surgical management—will take place is difficult to say; but more about the future later.

**Obesity Epidemic: Understanding the Obesity Disease**

The prevalence of obesity in the United States has increased from 12% in 1962 to about half of the present population. It has been estimated that there are 23 million people in the United States with a body mass index (BMI) of no less than 35 kg/m² and 8 million with a BMI of 40 kg/m² or higher. Globally, the statistics are also staggering, with approximately 2 billion individuals documented as overweight (BMI of 25 kg/m²–29.9 kg/m²), approximating the number of individuals who are starving worldwide.

Obesity results from a long-term imbalance between energy intake and energy expenditure, favoring positive energy balance, expansion of adipose lipid storage, and adipogenesis. The mechanisms for this disease, greatly influenced by genetic predisposition, reside in the pathways between the gut, the adipocyte mass, and the brain. Various hormones and neuropeptides are responsible for communication among body organs to influence consumption, absorption, and metabolism.

Obesity is associated with comorbidities that essentially involve every organ system (eg, hypertension, dyslipidemia, type 2 diabetes, obstructive sleep apnea [OSA], back and disk disease, peripheral osteoarthritis, gastroesophageal reflux disease, multiple carcinomas, depression, etc). As a result, life expectancy is markedly reduced in the obese individual, and other areas of the person’s life, such as psychosocial and economic aspects, are greatly affected.

**History of Bariatric Surgical Procedures**

This subject has been addressed several times in the past by the author, and various diagrams of the operative procedures are available. Today, the ever-changing preference of surgical procedures favors the relatively simple and safe, totally restrictive laparoscopic adjustable gastric banding (LABG); the well-practiced, restrictive/malabsorptive Roux-en-Y gastric bypass (RYGB); and the most effective, primarily malabsorptive biliopancreatic diversion (BPD)/duodenal switch (DS). For each classification of procedure, there are numerous technical variations, and the preponderance of bariatric surgery is currently performed laparoscopically. Many have postulated the construction of an algorithm to match a particular patient to a specific operation.

Most bariatric surgeons and nonsurgeons agree with the principle of an algorithm; however, none has been subjected to critical assessment and in practice, the preference and capability of the surgeon seems to be the primary factor in the selection of a procedure.

**Worldwide Bariatric Surgery**

The treatment of morbid obesity with bariatric surgery has spread worldwide. Results of a 2003 questionnaire answered by the membership of the International Federation for the Surgery of Obesity (IFSO) estimated that approximately 150,000 bariatric procedures were performed in 2002-2003 by some 3,000 bariatric surgeons (Figure 1). The number of procedures performed in the United States was estimated at 103,000. Nations performing at least 2,000 operations annually were France (12,000), Belgium (6,000), Brazil (4,000), Italy (3,000), Australia/New Zealand (2,750), Egypt (2,750), Mexico (2,500), and Spain (2,000). All of these numbers have markedly increased in the past 4 years. The United States now performs about 175,000 bariatric procedures annually and the world total is approximately 300,000, yet only about 1% of the eligible morbidly obese population is currently being offered the benefits of bariatric surgery.

**Outcomes**

The literature on the effects of bariatric surgery on the comorbid conditions of morbid obesity is extensive and beyond the scope of this review. Suffice it to say that essentially every comorbidity is resolved or ameliorated by successful, weight-loss-efficacious bariatric surgery. Table 1 reviews the proven medical comorbidities reversed or improved by bariatric surgery, and Table 2 reviews those comorbidities where reversal or improvement can reasonably be presumed. Additionally, successful bariatric surgery improves quality of life, body image, personal hygiene, and sexual function, as well as employment, income, and job or professional advancement.

In 2004, we published a systematic review and meta-analysis focusing on 4 comorbidities of morbid obesity: type 2 diabetes, hyperlipidemia, hypertension, and OSA. The study included 136 fully extracted studies for 22,094 patients. There were more women than men in the study (72.6%); the mean age was 39 years; and the baseline mean BMI was 46.9 kg/m² (range 32.3–68.8). The mean (95% confidence interval) percentage of excess weight loss was 61.2% (58.1%–64.4%) for all patients, 47.5% (40.7%–54.2%) for patients who underwent LAGB, 61.6% (56.7%–66.5%) for RYGB; 68.2% (61.5%–74.8%) for gastroplasty; and 70.1% (66.3%–73.9%) for those undergoing BPD/DS.
Operative mortality (≤30 days) in the extracted studies was 0.1% for the purely restrictive procedures, 0.5% for RYGB, and 1.1% for BPD/DS. Diabetes was completely resolved in 76.8% of all patients and resolved or improved in 86%. Hyperlipidemia improved in 70% or more of patients. Hypertension was resolved in 61.7% of patients and resolved or improved in 78.5%. OSA was resolved in 85.7% of patients, and was resolved or improved in 83.6% (Table 3).

We have subsequently conducted 2 follow-up meta-analyses, the first on operative mortality at 30 days or less and 31 days to 2 years, and the second on type 2 diabetes, both to be published in 2007. In each, the database was considerably expanded: 85,048 patients for the mortality meta-analysis and 135,246 patients for the diabetes meta-analysis.

Complications of bariatric surgery vary according to the procedure performed and, unfortunately, as a function of the skill and experience of the surgeon. With the advent of laparoscopic surgery, and in particular laparoscopic bariatric surgery, the term “learning curve” has been exploited. With appropriate training and supervised surgical beginnings, a learning curve should imply increased time per procedure and possibly even an increase in adverse events, but should not be an excuse for excess mortality.

The resolution or improvement in comorbidities has now been demonstrated to increase patient longevity. Christou et al completed the first definitive major study to demonstrate this finding. The study showed a statistically significant 89% (P<0.001) decrease in mortality at 5 years (control 6.17%, surgery 0.68%) with a risk ratio of 0.11 (0.04–0.27; Figure 2). These findings

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**Figure 1. Bariatric surgery performed worldwide in 2003**

**Table 1. Effects on Comorbidities**

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<th>Reversal or Improvement Proven</th>
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<tr>
<td>1. Type 2 diabetes</td>
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<td>2. Hyperlipidemia</td>
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<td>3. Hypertension</td>
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<td>4. Obstructive sleep apnea</td>
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<td>5. Cardiac function failure</td>
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<td>6. Asthma</td>
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<td>7. Back strain and disk disease</td>
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<td>8. Weight-bearing osteoarthritis (hips, knees, ankles, feet)</td>
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<td>9. Gastroesophageal reflux disease</td>
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<td>10. Nonalcoholic fatty liver disease and cirrhosis</td>
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<td>11. Stress incontinence</td>
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<td>12. Polycystic ovarian syndrome</td>
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<td>13. Intertriginous dermatitis</td>
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<tr>
<td>14. Pseudotumor cerebri</td>
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<td>15. Depression</td>
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were substantiated in 4 papers presented at the World Congress of the IFSO in 2006.30

**Cost-Benefit**

Sampalis et al also showed that the 5-year health-care utilization data for hospitalizations, hospital stay, and physician visits all indicated a greater use of healthcare facilities by obese controls in comparison with patients who had undergone bariatric surgery.31

Accounting for the initial cost of the operative procedure and hospital care, the costs for the obese control patients exceeded those for the bariatric patients before 4 years, with continued divergence thereafter (Figure 3).

The literature on the financial benefits of bariatric surgery is quite substantial, and has been well-reviewed by Martin, who stated, “To date, only bariatric surgery has been shown to treat any form of obesity in a truly cost-effective manner.”20

**Regulation**

The earliest widely-accepted guidelines for regulating bariatric surgery were published in 1991 by the National Institutes of Health (NIH) as a Consensus Statement outcome of a Consensus Conference.32 This statement defined as the criteria for performing bariatric surgery a BMI of no less than 40 kg/m² or a BMI of no less than 35 kg/m² in the presence of high-risk comorbid conditions. This document continues to be cited as the regulatory standard, even though it was confined to open surgery, and the statement only sanctioned vertical banded gastroplasty and RYGB.

To remedy this situation, under the auspices of the American Society for Bariatric Surgery (ASBS), a Consensus Conference was held in May 2004.33 The Consensus Panel was comprised of 6 surgeons and 6 nonsurgeons. The panel concluded with 10 recommendations:

1. A multidisciplinary team approach and available additional clinical expertise is necessary.
2. Surgical candidates should have attempted weight loss by nonsurgical treatment options.
3. Surgical candidates should have a comprehensive medical evaluation, but evaluation by subspecialists (eg, cardiologists, psychiatrists/psychologists) is not routinely needed.
4. Currently recommended procedures are RYGB, LAGB, vertical banded gastroplasty, and BPD/DS.
5. Surgeons should be receptive to change and new procedures.
6. Both open and laparoscopic surgeries are the standard of care.
7. Further experience should be obtained in obese adolescents.
8. Consideration should be given to extending the benefits of bariatric surgery to class 1 obesity (BMI 30 kg/m²-34.9 kg/m²) patients who have a condition that can be cured or markedly improved by substantial and sustained weight loss.
There should be critical examination of the cost–benefit ratio of bariatric surgery. There is need for increased clinical investigation, basic research, and education.

In a 2006 landmark ruling, the Medicare system opened bariatric surgery to patients over 65 years with a proviso that the surgery be performed in Centers of Excellence accredited by either the Surgical Review Corporation (SRC) or the American College of Surgeons. Unfortunately, and as expected, US insurance carriers did not broaden their prior authorization criteria for bariatric surgery as a result of this ruling.

Accreditation in bariatric surgery provides the benefits of setting minimal standards of care for surgeons and institutions, establishing policies to exclude and remove substandardly trained and performing surgeons and institutions; rewarding qualifying performance with Centers of Excellence designation, enhancing safety and care of the bariatric surgery patient, promoting access to care for the bariatric patient, and distinguishing bariatric surgery as a surgical discipline or specialty. To achieve accreditation for bariatric surgeons, the IFSO Cancun Statement was issued in 1997, followed by The Society of American Gastrointestinal Endoscopic Surgeons (SAGES) Guidelines for Laparoscopic Bariatric Surgery in 2003 and the ASBS–SAGES Guidelines for Granting Privileges in Bariatric Surgery 2003, revised 2005.

Despite these efforts, the community response faced a year of crisis in 2003: Disbelief in bariatric surgical outcomes was high; reports of high complication rates were published; malpractice litigations increased; coverage by insurance carriers decreased; and centralized data for response by the bariatric surgery community to unwarranted criticism was lacking. This crisis resulted in at least 20 insurance carriers establishing their own Centers of Excellence programs. Multiple programs lead to multiple standards, multiple demanding applications, data sets too small to be useful, arbitrary decisions from providers, and no sharing of data. Most significantly, the bariatric surgery community was, as a rule, not involved in the decision-making process by the provider-initiated Centers of Excellence.

The response of the bariatric surgical community was the establishment of the ASBS-sponsored SRC in 2005. The SRC is an independent, nonprofit organization with broad representation of stakeholders on the Board of Directors—including industry, carriers, consumer advocates, surgeons, and nurses. The basic tenant for Center of Excellence designation by the SRC is the presence of both a qualified bariatric surgeon and a qualified institution for the performance of bariatric surgery. To achieve these performance standards, the institution must perform at least 125 bariatric surgical cases per year, and the applicant surgeon needs to perform at least 125 lifetime cases, with at least 50 cases in the preceding 12 months.
The Question

The future evolution of therapy for morbid obesity will include nonsurgical innovations: possibly new diets of noncaloric foods, newer methods of behavior modification, newer and more effective drugs, hybridization of drugs and bariatric surgery, management of the intestinal flora that may facilitate caloric absorption, anti-etiologic viral agents, and gene therapy. Strictly surgical innovations will most certainly consist of newer procedures to influence gastric and intestinal metabolism, possibly central nervous system or intravenous incretins infusions by implantable pumps, and possibly hypothalamic stimulation and/or ablation. Whatever the next decade or so has in store for the treatment of morbid obesity, bariatric surgeons can take pride in the accomplishment of a challenging task when there was no effective therapy.

Recently, the author exchanged comments with a prominent internist-obesity expert at a meeting on obesity management. The internist, flagellated surgeons, questioning the outcomes of bariatric surgery, stating that the operative mortality and complications must be higher than reported. The author responded by giving available evidence-based data and, in turn, questioned the internist with respect to the medical management of morbid obesity. Because the success rate for even a 10% loss of excess body weight is less than 10% for diet and drug therapy, the cumulative mortality and development of comorbid complications of medical therapy must be many-fold that of surgical therapy, over time approaching 100%. The author asked him whether medical therapists had even published their own extended mortality and morbidity rates, whether they had performed meta-analyses of their data, and whether they had a medical counterpart of the SRC or any other central repository of data. The response was silence.

Most assuredly, at this time in history, morbid obesity is a surgical disease.

References


*Dr. Buchwald is a consultant to Ethicon Endo-Surgery Inc. and Fulfillium, Inc.*
Recent estimates state that 64% of the US population is overweight, defined as having a body mass index (BMI) of 25 kg/m² or more, and 30% of the population is morbidly obese, defined as having a BMI of 30 kg/m² or more. In part secondary to it, has been the dramatic increase in the number of bariatric surgeries performed annually. Between the early 1990s and 2003, the number of bariatric surgeries has increased 644%. A growing body of literature confirms that bariatric operative procedures have become safer and more effective, yielding significant and sustainable weight loss. More important than the actual number of pounds shed, are the dramatic improvements in health achieved by patients undergoing these procedures.

Although bariatric surgery is the only treatment modality for patients who are obese, not all of these patients should undergo this type of surgery. Obesity is multifactorial in origin and complex in nature. In addition to genetics, factors such as as behavior, social habits, and even environment, can have a significant impact on results and outcome. Because many morbidly obese patients have poor health, and the surgical procedures are complex and have the potential for catastrophic complications, it is crucial that clinicians select patients likely to do well and weed out those who have unacceptable risk or a higher likelihood of a poor outcome.

**Scott A. Shikora, MD, FACS**

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Boston, Massachusetts
National Institutes of Health Consensus Statement on Obesity

The first standards for patient selection for surgery were developed in 1991 by an expert panel convened by the National Institutes of Health (NIH). At the time, the only operative procedures being performed were the Roux-en-Y gastric bypass (RYGBP) and the vertical-banded gastroplasty (VBG). At that time, these procedures were only performed in an open fashion because laparoscopy had not yet entered the realm of bariatric surgery. Based on the best available evidence at that time, the panel recommended minimum criteria for surgical candidates (Table 1).

These standards are 16 years old and much has changed in medicine and bariatric surgery, most notably the introduction of laparoscopy, improved perioperative care, and the introduction of new procedures such as the laparoscopic adjustable gastric band (LAGB) and biliopancreatic diversions (Table 2). However, the NIH standards were validated recently by the Massachusetts Betsy Lehman Center for Patient Safety and Medical Error Reduction’s Expert Panel on Weight Loss Surgery and the Center for Medicaid & Medicare Services. In both cases, extensive review of the medical literature was performed.

Patient-Selection Criteria

Despite the validity of the NIH standards, simply meeting them does not mean that a patient is a good candidate for surgery. Surgeons are not obligated to operate on all patients who present to their offices. A number of factors must be considered when determining whether to offer surgery to patients who meet the NIH criteria (Table 3). Patients can be denied obesity surgery for behavioral, medical, surgical, or other reasons. However, unlike the NIH standards, which were based on the best available evidence, there is a paucity of literature that has analyzed the process of selecting and excluding patients, and there are no codified standards. Most of the available information is based on the opinion of experienced bariatric clinicians. For example, most credentialing organizations mandate that the patient-selection process use a multidisciplinary team of clinicians, including the surgeon, behavioral therapist, and a dietitian/nutritionist. However, there are no published studies that validate the benefit of such a process. Therefore, consistent with the lack of science in the patient-selection process, the statements expressed in this article mainly represent either the prevailing attitudes of veteran bariatric surgeons and/or the opinion of the author who has more than 16 years of experience.

First and Foremost, Know Your Limitations

To minimize preventable complications and poor outcomes, each surgeon must consider his or her own abilities, experience, hospital resources, and support network. For instance, less experienced surgeons, or those working in smaller community facilities, may opt to be more restrictive in their selection than an experienced

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<th>Table 1. 1991 NIH Consensus Statement Criteria</th>
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<tr>
<td>BMI &gt;40 kg/m² with or without comorbidity</td>
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<tr>
<td>BMI &gt;35-39 kg/m² with major comorbidity</td>
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<tr>
<td>Demonstrated repeated failure of nonsurgical weight-loss strategies</td>
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<tr>
<td>No history of significant psychiatric disorders</td>
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<td>Multidisciplinary evaluation</td>
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<th>Table 2. Changes in the Field Of Bariatric Surgery Since 1991</th>
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<tr>
<td>Marked increase in the incidence of obesity</td>
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<td>Expansion of available procedures (LAGB, BPD)</td>
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<td>Improved safety of the procedures</td>
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<td>Introduction of laparoscopy</td>
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<td>Increased experience with team management</td>
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<tr>
<td>15 years more experience with bariatric surgery</td>
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<tr>
<td>Better understanding of the comorbid conditions</td>
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<td>Documentation that delaying surgery diminishes its effectiveness</td>
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<tr>
<td>Demonstration that surgery improves quality of life</td>
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<tr>
<td>Data that demonstrates that surgery is cost effective</td>
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BPD, biliopancreatic diversion; LAGB, laparoscopic adjustable gastric band
Based on reference 6.
surgeon or one who works in a large medical center. The former may be wise to limit their practice to lower risk patients and refer the higher risk patients to a major medical center or to a more experienced surgeon. There is no room in the selection process for a surgeon’s ego. Additionally, the exclusion criteria might change with time. For example, as the surgeon with limited experience gains more experience or acquires more resources, he or she may become less restrictive.

**Behavioral Screening Process**

The goal of the behavioral screening process is to identify patients who can comprehend and adjust to the life-changing effects of the surgery, and are likely to maintain the long-term behavioral changes necessary for success. Although all of the current bariatric procedures generally result in weight loss, outcome is ultimately determined by behavior. To uncover potentially problematic behavior patterns, a thorough preoperative psychological evaluation should be performed. This should focus on weight history, social situation, life stresses, and dietary history to identify problem areas that may negatively affect results. Patients must show evidence of stress and dietary control, supportive relationships, and a stable living environment. Few published papers are available for reference when designing a behavioral screening process. Several questions need to be answered: Is there benefit to standardized testing versus one-on-one counseling? How much behavioral intervention is necessary pre- and postoperatively? Can a poor candidate be rehabilitated? If so, how long would it take?

The screening process should uncover factors that will increase the risk of inadequate weight loss or weight regain. Patients should not display evidence of eating disorders, such as active severe bulimia, that may preclude compliance with postoperative dietary restrictions. Persistent maladaptive eating behavior and dietary indiscretion can result in the failure to lose weight despite an excellent surgical result. Patients with significant psychiatric disorders or mental retardation should be very carefully scrutinized for the potential for postoperative noncompliance. Additionally, active substance abuse or self-destructive behavior should preclude patients from consideration. However, in many cases, patients initially rejected from surgical consideration because of behavioral issues can be reevaluated for surgery if they respond favorably to psychiatric or psychological therapy. Finally, surgery should be reserved for patients who appear to be well-informed, motivated, and have a realistic understanding of how surgery will produce weight loss and acknowledge that surgery itself does not guarantee a good result. They must also understand that surgery and the resultant weight loss will not “cure” all of their social and behavioral problems. Table 4 lists behavioral factors that would be exclusions from bariatric surgery.

There are other behavioral attributes that may not represent absolute contraindications for surgery, but should, at the very least, raise red flags (Table 5). These

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<th>Table 3. Patient-Selection Criteria</th>
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<tr>
<td>1991 NIH Consensus Panel Statement on Obesity</td>
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<td>Surgeon’s experience and available resources</td>
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<td>Behavioral and social assessment</td>
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<tr>
<td>Medical assessment</td>
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<tr>
<td>Surgical assessment</td>
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<tr>
<td>Miscellaneous factors</td>
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<tr>
<td>· Overall impression</td>
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<tr>
<td>· Age</td>
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<td>· Previous bariatric surgery</td>
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<th>Table 4. Behavioral Exclusions From Bariatric Surgery</th>
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<tr>
<td>Significant psychiatric disorders or major depression</td>
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<td>Severe mental retardation</td>
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<td>Self-destructive lifestyle</td>
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<tr>
<td>Active bulimia</td>
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<tr>
<td>Drug or alcohol abuse</td>
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<tr>
<td>Inability to comprehend the necessary behavioral changes</td>
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<td>Inability to integrate basic lifestyle adjustments preoperatively</td>
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include abusive behavior toward staff members, missed appointments, short temperedness, impatience with the speed of the process, or pleas to abbreviate the process. Additionally, patients who do not stop smoking, have significant alcohol consumption, or gain weight during the preoperative period are likely to be noncompliant after surgery; it is recommended that they not be offered surgery until they demonstrate successful compliance with program requirements.

Medical Screening for Surgery

It seems ironic that although bariatric surgery improves or “achieves remission” for most of the obesity-associated medical conditions, these same conditions could actually disqualify a patient from surgery. For instance, surgery may not be reasonable for patients whose underlying health is extremely poor, and when the predicted operative risks secondary to the comorbid conditions are extremely high. This is a subjective issue, and it is difficult to assign absolute percentages of risk that can be used as guidelines for proceeding with or denying surgery. However, DeMaria et al.13 developed a risk-scoring system that may aid in evaluating high-risk patients. Patients deemed to have a poor quality of life from comorbidities that would not be expected to improve with weight loss should also not undergo surgery. Additionally, as stated earlier, the criteria for “acceptable risk” will be influenced by many factors including the surgeon’s experience, hospital resources, and level of support from other clinicians.

Some medical conditions that might preclude patients from surgery include incurable diseases such as cancer, AIDS, and end-stage conditions such as heart disease, chronic obstructive pulmonary disease, and cirrhosis with portal hypertension. Other conditions may also prevent patients from undergoing surgery or may alter the operative approach or procedure performed. These conditions include Crohn’s disease, chronic renal or liver disease, radiation enteritis, and intestinal dysmotilities. Table 6 lists some medical considerations for bariatric surgery.

Surgical Considerations for Surgery

There are far fewer surgical reasons to exclude patients from surgery than medical or behavioral reasons. However, it is important to have knowledge of all of the patient’s prior abdominal surgeries. That information can be obtained from a thorough history and physical examination but should be supplemented by obtaining operative reports and radiographic studies. Previous gastrointestinal surgery may alter the operative options. For instance, patients with significant lower abdominal procedures or small bowel resections may be better served by gastric banding than gastric bypass. Patients who have had previous surgery at the gastroesophageal junction may be better served with a biliopancreatic diversion. However, it is also important that the surgeon only performs procedures that he or she is comfortable and competent doing.
There are some surgical conditions that would preclude a patient from bariatric surgery. For example, although it is unlikely that a patient who has had a partial or total gastrectomy would be morbidly obese, if such a patient existed, it might be reasonable not to consider a bariatric procedure. Additionally, patients who have had multiple previous abdominal surgeries, other gastric procedures, abdominal radiation, or liver transplantation may also be considered “noncandidates” for bariatric surgery.

**Miscellaneous Considerations for Surgery**

There are additional considerations when evaluating patients as prospective candidates for bariatric surgery. First, one must pay attention to initial impressions. If for any reason, the clinician “gets bad vibes” about a particular patient, that patient needs to be considered very carefully before being offered surgery. As long as the reason for denying surgery is not based on discrimination or other bias, the team has the right (and the moral responsibility) to be choosy. Some reasons to deny a patient surgery can be quite subjective. Patients who might normally be considered good candidates for surgery may be living through a family trauma or unsettled home environment. These may include a death in the family, marital or financial difficulties, and so on. Patients who have recently experienced a psychiatric hospitalization or alcohol or drug abuse also should not be considered for surgery until their situations stabilize.

Patients who have failed a previous bariatric procedure warrant special consideration. Most failure is behavioral in nature and not likely to benefit long-term from revisional surgery. Patients with intact bariatric anatomy are especially likely to do poorly because they have no anatomic excuses. There are no good data published to support banding the pouch, decreasing pouch size, lengthening the roux limb, or narrowing the gastrojejunostomy to promote sustainable weight loss in patients who have had poor outcomes after “successful” bariatric surgery. However, patients with disrupted anatomy and those who have had restrictive procedures, such as the LAGB, the VBG, or older, less effective procedures such as the horizontal gastroplasty, may benefit from conversion to another procedure. Most bariatric programs would consider such patients for surgery, but would likely have them first undergo a thorough preoperative behavioral evaluation.

At this point, there are no universally accepted guidelines regarding age limits for bariatric surgery. The 1991 NIH standards did not address age because there were limited available data on the safety and effectiveness of surgery on adolescents and senior citizens when they were developed. Traditionally, surgery has been reserved for adult patients between the ages of 18 and 50 years.

Adolescent and childhood obesity also represents a growing health concern in today’s society. Although many obese adolescent patients are physically healthier than their adult counterparts, many present with

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**Table 6. Medical Considerations For Bariatric Surgery**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the comorbid diseases severe enough that they would create unacceptably high operative risk?</td>
<td></td>
</tr>
<tr>
<td>Does the patient have incurable diseases (cancer, AIDS, severe cirrhosis, etc)?</td>
<td></td>
</tr>
<tr>
<td>Disease control (congestive heart failure, angina, thyroid disease, etc).</td>
<td></td>
</tr>
<tr>
<td>The presence or absence of gastrointestinal disease such as dysmotilities, radiation enteritis</td>
<td></td>
</tr>
<tr>
<td>Would the overall quality of life likely improve with weight loss?</td>
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similar health profiles and suffer from the same comorbid conditions, such as diabetes mellitus, hypertension, sleep apnea, and steatohepatitis. Many children and adolescents would also pose operative risks that are similar to those of adults. Additionally, children and adolescents may lack the behavioral maturity necessary to result in good long-term outcomes. Therefore, for the last few decades, adolescent candidates for surgery were evaluated on a case-by-case basis. Retrospective reviews of adolescents who underwent GBP\textsuperscript{14} or LAGB\textsuperscript{15} demonstrated minimal morbidity and outcomes that were similar to those observed for adult patients. Based on the results of these studies and additional patient experience, Garcia et al\textsuperscript{16} and the Massachusetts Betsy Lehman Panel\textsuperscript{17} have published best practice guidelines for considering adolescent patients for surgery.

At the other end of the spectrum, surgery was traditionally restricted to patients younger than 50 years.\textsuperscript{18,19} This was based on earlier studies that demonstrated higher operative morbidity and mortality in older patients. However, advances in operative technique, including the expanded use of minimally invasive procedures and improvement in perioperative care have enabled many surgeons to offer surgery to older patients. Studies analyzing the results of other major surgeries on older patients have generally found that although morbidity and mortality was often higher for this population, the results were generally favorable.\textsuperscript{20,21} Recent reviews of laparoscopic bariatric surgery on older patients have resulted in similar findings. Older patients generally have demonstrated “acceptable” morbidity and similar outcomes to younger adult patients.\textsuperscript{22,23} However, when considering whether to offer surgery to an elderly patient who otherwise meets the standard requirements, the surgeon should always consider whether the surgery will enhance the patient’s quality of life and whether the patient has the potential to live for a considerable number of years beyond the surgery.

\textbf{Conclusion}

Despite the seemingly infinite pool of prospective patients for bariatric surgery, the uniqueness of the disease and its surgical treatment mandates that only appropriate patients undergo surgery. Patients who are poorly selected may be at greater perioperative risk or may have poor outcomes. Although there are no truly validated regulations for patient selection, some guidelines do exist. The 1991 NIH Consensus Panel on Obesity Statement is the foundation from which to design selection criteria. The surgeon’s experience and facility resources will also affect the selection criteria. A multidisciplinary evaluation including (but not necessary limited to) behavioral, medical, and surgical consultations will likely be of benefit. Patient age and previous bariatric surgery will need to be considered by clinicians on a case-by-case basis.

\begin{thebibliography}{100}
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\textbf{Dr. Shikora has no relevant financial information to disclose.}
Top 10 Questions About Obesity Surgery and Teens

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Introduction

Extreme obesity poses critical threats to the health of our youth. Medical and behavioral interventions rarely result in the significant, durable weight loss necessary to improve health outcomes, prompting a search for more aggressive measures.

Obesity is increasing in epidemic proportions, with disproportionate gains in the prevalence of extreme obesity in adults and children alike. Although dietary and behavioral approaches represent the mainstays of treatment of childhood obesity, bariatric surgery is increasingly being considered as an option for the treatment of adolescents with significant obesity-related comorbidities. This trend is primarily a result of the increasing understanding that lifestyle modification and behavioral and dietary approaches are ineffective for those with extreme obesity. Furthermore, the recognized success of bariatric surgery in obese adults has gradually led clinicians to become more receptive to this approach for younger patients. This article answers 10 of the most commonly asked questions about surgical approaches to adolescent obesity.

Question 1: What is extreme pediatric obesity?

In nationwide data from 2004—the latest available—7% of women and 3% of men were extremely obese. However, this disease is no longer limited to adults—it is increasingly affecting children. For this demographic, a single body mass index (BMI) number does not adequately define obesity because of height changes throughout preteenage and into midteenage years. Therefore, obesity can be identified in children and adolescents by indexing BMI to age and presenting it as percentiles (Figure 1). A BMI for age greater than or equal to the ≥95th percentile has commonly been used to indicate "obesity" in pediatric populations. A BMI for age greater than or equal to the 99th percentile is
now considered “extreme” or morbid as this percentile curve tracks toward BMI values of 35 to 40 kg/m² by 18 years of age, when the height growth is expected to stop. Interestingly, according to this definition, 4% of all children and adolescents are extremely obese; this is very similar to the prevalence of extreme obesity in adults. Moreover, of the extremely obese children in the United States, nearly 60% harbor 2 cardiovascular risk factors, and when followed into their 30s, their adult BMI is 43 kg/m² on average. Thus, extreme childhood obesity is arguably a public health crisis as prominent as in adult age groups.

**Question 2: How did we get here?**

The short answer is that the obesity epidemic proves the concept that energy in must equal energy out, but the longer answer is more interesting. Our early ancestors possessed powerful physiologic processes to defend against weight loss in times of famine. These protective mechanisms involved storing excess energy as fat for use during times when food was scarce. For millions of years, this plan served us well. However, in most industrialized countries today, we have developed and refined the food production industry such that no supply shortage exists. Our manufacturing processes that serve to enhance shelf life and thus usability of food actually removes the healthy fiber component, leaving the tasty salts, sugars, and fats in place. The same revolution that has all but eliminated food shortage has also resulted in the mechanical automation of society, so that energy intake is virtually unlimited and less physical activity is necessary in our daily lives, leading to energy imbalances that accumulate day after day.

There is abundant scientific evidence of a central “barostat” that controls the body’s innate response to weight loss—activating anabolic pathways and deactivating catabolic pathways in response to volitional weight reduction. With such a sophisticated system resisting weight loss, the ever-increasing pediatric obesity problem may represent an expected biologic outcome given the environment in which our children are being raised.

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*Figure 1. BMI for age curves for obesity and extreme obesity.*

Adapted from original artwork by Susan Rose, MD, with additional data adapted from Freedman DS et al.®
Question 3: Is obesity really a major problem for children?

Childhood and adolescent obesity have been associated with a number of significant health problems (Figure 2). This condition results in a highly increased risk of hypertension, hypercholesterolemia, hypertriglyceridemia, hyperinsulinemia, and atherosclerosis.8,9 Type 2 diabetes mellitus also has been more frequently diagnosed in adolescents, particularly among those who are obese. The incidence of type 2 diabetes in children has grown 10-fold during recent decades;10 one third of toddlers today are expected to be affected by this costly and debilitating problem at some point in their lifetimes. Obese adolescents also are at substantial risk of metabolic syndrome; 33% to 50% have been identified with this dangerous clustering of risk factors for cardiovascular disease.11,12

Obstructive sleep apnea (OSA) syndrome occurs more frequently in obese children13 and has serious adverse effects on daytime learning and quality of life.14 More than 50% of all teens seeking bariatric surgery have this condition.15 Obese children also are at increased risk of pseudotumor cerebri,16 skeletal complications, and polycystic ovarian syndrome (girls).9 Risk of gynecologic and gastrointestinal malignancies has also been closely linked with obesity, specifically with BMI during the teen years.17 Nonalcoholic steatohepatitis also occurs in obese adolescents14,18,19 and may eventually prove to be an important cause of end-stage liver disease for young adults who were obese children.

Figure 2. Comorbidities of obesity in children.
DVT/PE, deep vein thrombosis/pulmonary embolism; GYN, gynecologic
Obese adolescents are more stigmatized\textsuperscript{20,21} by peers and cite fewer friendships\textsuperscript{22} than adolescents without weight problems. As young adults, they have higher high school dropout rates, lower quality-of-life satisfaction,\textsuperscript{23} lower rates of marriage, and lower family income.\textsuperscript{24}

Obesity is associated with at least a 2-fold elevation in mortality risk during a 30-year period of follow-up.\textsuperscript{25,26} Racial differences in the risk of premature mortality have also been identified, with black men and women losing more than 20 years and 5 years, respectively, and white men and women losing 13 years and 8 years, respectively, as a result of extreme obesity in their young adult years.\textsuperscript{27}

**Question 4: Why consider surgery for adolescent obesity?**

Behavioral weight management programs for obese and adolescents have been somewhat more effective than similar programs for adults.\textsuperscript{28} However, behavioral programs have low attendance rates and suboptimal weight reduction for extremely obese adolescents.\textsuperscript{29} Indeed, research suggests that adolescents with BMI values exceeding 40 kg/m\textsuperscript{2} have a reduction in BMI of 3\% or less after participating for 1 year in an organized weight management program.\textsuperscript{30} Poor weight loss results have also been reported for preadolescents with extreme obesity.\textsuperscript{31} Furthermore, pharmacologic trials in adolescents with orlistat (Xenical; Roche) have also demonstrated 5\% or lower pharmacologic trials in adolescents with orlistat meaningfully, lasting weight loss.

**Question 5: What are the national trends in use of adolescent bariatric surgery?**

Bariatric surgery has been used for the treatment of extreme obesity for almost 50 years in the United States. Bariatric surgery is a proven treatment for extremely obese adults, and several procedures were endorsed in 1991 by a Consensus Development Conference of the National Institutes of Health (NIH).\textsuperscript{34} Bariatric surgery is recommended for the extremely obese who have failed prior nonsurgical obesity management attempts, caused primarily by the clearly demonstrated adverse effects of adult obesity on all-cause mortality.\textsuperscript{35} Similarly, as we observe the rising physical, medical, and psychosocial comorbidities in extremely obese in pediatric age groups, we are increasingly obligated to evaluate the patients for surgical therapy.

To date, there have been very few population-based studies evaluating the use or safety of bariatric surgery for adolescents. Recently, however, data pertaining to nationwide trends in the use of adolescent bariatric surgery\textsuperscript{36} and basic comparisons of early postoperative outcome between adolescents and adults have been published.\textsuperscript{37} Between 1996 and 2003, nearly 3,000 bariatric procedures were performed on adolescents, during which period the annual rate climbed more than 3-fold. As of 2003, the operation of choice for both adults and adolescents was gastric bypass, representing about 90\% of all cases.\textsuperscript{38} Adolescents comprised 0.7\% of all patients undergoing bariatric surgery in 2003, and they typically presented with significantly fewer comorbid medical conditions than adults. Hospital stays were minimally shorter for adolescents (3.2 days) than for adults (3.5 days). In-hospital cardiac, infectious, renal, and surgical complication rates were modestly lower in adolescents, although no significant differences in the overall complication rates were observed. In-hospital deaths were seen in 0.2\% of adults, yet no inpatient adolescent deaths were recorded in 2003 or in any other year, suggesting that despite extreme obesity, the younger set is more fit to undergo these major operations.

**Question 6: What are the special considerations when adolescents are referred for surgical weight loss?**

When considering surgical weight loss for teenage patients, physicians must be aware that despite very high BMI values, most extremely obese adolescents do not exhibit the same severity of comorbidities that justify surgical intervention in their adult counterparts. Therefore, the rationale for medical decision making necessarily differs somewhat between adolescents and adults.

Physicians must also be aware of the need to completely prepare adolescents for an intervention that will change their eating patterns for life and the possible effects of future reproductive outcomes, growth, and development. Extremely obese teenagers are often malnourished at baseline, and there is apprehension regarding the adequacy of micronutrient intake at baseline prior to surgery and the possible effect of preoperative nutritional status on development of postoperative nutritional deficiency syndromes.\textsuperscript{38,39} In addition, concern has been raised about vitamin and mineral compliance in adolescents undergoing weight loss surgery.\textsuperscript{40} Folate, for example, is critically needed for normal organogenesis during pregnancy. A conservative nutritional management approach advocated for adolescents is to begin education regarding postoperative nutritional practices with families early in the bariatric evaluation process and to implement multivitamin and mineral supplementation several weeks preoperatively to replenish micronutrients that may have been deficient preoperatively. Because of the specific risk of beriberi following gastric bypass, it has been recommended that a separate vita-
Question 7: What are the indications for bariatric operation in adolescents?

To date, there is no strong evidence to suggest that indications for bariatric surgery in adolescents are different from those applied to adults. However, because of the often delayed health implications of pediatric extreme obesity and the insufficient data for the long-term risks and durability of surgical therapy in adolescents, conservative indications for operation have been proposed. There has been debate about whether one should consider extreme obesity as an indication for operation in adolescents in the absence of comorbidities. Most pediatric experts agree that candidates for surgery should have a BMI of at least 40 kg/m² and manifest an identifiable physical or psychosocial comorbidity of obesity to justify an invasive surgical procedure with lifelong consequences. This is a contrast to the time-honored NIH guidelines for adults that indicate that a BMI of 40 kg/m² or more without specific comorbidities justify this surgery. Like adults, teens considering surgery should have demonstrated failure of nonoperative weight management approaches. Surgery should not represent a first-line intervention.

Question 8: Where should adolescent bariatric surgery be performed?

Adolescents under consideration for bariatric surgery should be referred to specialized centers with a multidisciplinary bariatric team. Whether such programs are based in primarily adult or pediatric hospitals, basic institutional and program standards should be met (Table). The patient care team should include an experienced bariatric surgeon with a subspecialty interest in adolescent patients, a pediatrician with weight management expertise, a psychologist with adolescent expertise, a dietician with special focus on bariatric nutrition, an advanced practice nurse dedicated to care coordination for this special-needs patient group, and an expert in physical activity. Depending on the individual needs of the adolescent patient, additional expertise in adolescent medicine, endocrinology, pulmonology, gastroenterology, cardiology, orthopedics, and ethics should be readily available. Specialized adolescent bariatric programs already exist in a number of medical centers in the United States and are in the process of being established in other centers.

Question 9: What is the best operation for adolescents?

The definitive answer to this question is not known for either adults or adolescents. A large Australian experience with adjustable gastric banding in adults has been informative regarding the consequences of significant weight loss on adult obesity and comorbidities. The largest adolescent series to date is also Australian. This study consisted of 41 adolescents ranging in age

Table. General Institutional and Program Standards for Adolescent Bariatric Specialty Centers

<table>
<thead>
<tr>
<th>Institutional</th>
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<tbody>
<tr>
<td>Support for bariatric surgical initiatives is available at all levels of administration.</td>
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<tr>
<td>Guidelines and patient care protocols that standardize clinical management should be available at all times for inpatient and outpatient medical and nursing staff.</td>
</tr>
<tr>
<td>Medical equipment, diagnostic instruments, and furnishings appropriate for the management of extremely obese patients and comfort of family members should be available throughout the hospital and clinic environment.</td>
</tr>
<tr>
<td>The institution has available consultative services required for the care of extremely obese patients.</td>
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<table>
<thead>
<tr>
<th>Bariatric Program</th>
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<tbody>
<tr>
<td>The program surgeon meets training criteria recommended by the American Society for Bariatric Surgery and dedicates significant time to bariatric care and continuing education.</td>
</tr>
<tr>
<td>The bariatric program maintains a medical director with expertise in pediatrics who participates in the decision-making process leading to surgery and in postoperative care.</td>
</tr>
<tr>
<td>The program is staffed with a trained bariatric patient care coordinator for close monitoring and continuing education needed in the postoperative care of adolescent bariatric patients.</td>
</tr>
<tr>
<td>The program maintains psychological and dietary staff with expertise in bariatric patient evaluation and management.</td>
</tr>
<tr>
<td>The program provides long-term medical follow-up of all patients undergoing bariatric procedures, with a monitoring and tracking system for outcomes assessment.</td>
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from 12 to 19 years. Patients had a mean weight of 125 kg and a mean BMI of 42 kg/m². Weight loss in the range of 30% was reported 3 years postoperatively in 18 patients in this series, for which 3-year data were available. Although all patients with comorbidities experienced improvement, there are little available data regarding the impact or durability of comorbidity change. Complications included gastric prolapse requiring band repositioning and mechanical problems with the device also requiring reoperation. In the United States, experience with gastric banding in adolescents is as yet insufficient to allow for definitive conclusions regarding effectiveness. In addition, the FDA has not yet approved any weight loss devices for pediatric patients. Controlled and prospective safety and efficacy trials for weight loss devices will be helpful for pediatric obesity specialists who are increasingly faced with difficult patient management decisions.

The gastric bypass is the standard against which all weight loss procedures must be measured. In adolescents, this procedure has been followed for more than a decade. Weight loss is approximately 33% following gastric bypass, and satisfactory preservation of lean mass (Figure 3) has been documented in small cohorts. Type 2 diabetes and OSA resolve after gastric bypass in adolescents, and major metabolic improvements also are seen. However, risk of intestinal leakage and delayed nutritional deficiencies, especially with B vitamins, remain a concern. Prospective multicenter studies that are now underway (www.cincinnatichildren.org/teen-LABS) will be helpful in advancing the understanding of the pros and cons of gastric bypass for extremely obese adolescents. In short, gastric banding is the least invasive technique but has lower weight loss efficacy, and possible revisional operations are a concern for teenagers with perhaps 5 or 6 decades remaining. The gastric bypass has been best characterized in terms of comorbidity change and durability of weight loss, but the short-term risks and costs are higher than those of the band and must be factored into decision making.

Question 10: What is the bottom line?

Extreme obesity poses significant threats to the health of our adolescents. Medical and behavioral interventions for extreme pediatric obesity rarely result in the significant, durable weight loss necessary to improve health outcomes. Bariatric surgery is a tool and must used within the context of a multidisciplinary program focused on reinforcement of healthy behaviors. Unlike other interventions, surgery can result in prolonged weight control and improvement in life-threatening obesity comorbidities and dismal psychosocial status. Thus, bariatric surgery performed during adolescence may be more effective than delaying surgery for extremely obese adolescents until adulthood. Controlled and prospective studies must be conducted to appropriately inform care decisions in this unique group of patients.

References

Bariatric Surgery: The Preoperative Assessment

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Preoperative patient preparation for bariatric surgery requires multidisciplinary involvement. It incorporates medical subspecialties, psychiatry, nutrition, and surgery to determine candidacy, identify and reduce peri- and postoperative risks, and find obstacles to long-term weight loss success.

After a 35-year surgical evolution, it is now established that a single operative procedure on the digestive tract can help most patients achieve durable and life-changing weight loss with resolution or improvement of many potentially life-threatening medical conditions.

Bariatric surgery—essentially unrecognized by the major surgical societies 10 years ago—is now a major agenda issue for most of the general surgery societies and boasts a thriving program in most major US medical centers.

The rapid and recent growth of this specialty has been stimulated by the universal acceptance that obesity is a chronic, progressive disease and now a major worldwide health problem. The public is now aware of the major health risks and impaired quality of life that accompanies severe obesity, and of the dramatic improvement that follows surgical treatment.

Bariatric surgery is unique among gastrointestinal surgical procedures because it serves as a behavior modification tool that, if used correctly, can be the catalyst to completely change the patient’s life. A prerequisite for the long-term success of surgical obesity treatment requires full patient participation in the life-changing process. The necessity for complete patient understanding and total involvement in the postoperative weight-loss and weight-maintenance process requires a more prolonged and laborious preoperative evaluation and preparation.

The preoperative patient preparation involves a multidisciplinary approach, including nutrition, psychiatry, medical subspecialties, and surgery for optimal patient
Table 1. Checklist: Information to Discuss With Candidates for Bariatric Surgery

| Success and failure rates of different bariatric procedures |
| Anticipated postsurgical weight loss |
| Noncurative nature of bariatric surgery |
| Bariatric surgery as a tool to change eating behavior |
| Health and quality-of-life benefits with surgical weight loss |
| Reduced mortality risk with surgical weight loss |
| The concepts of energy balance as they relate to weight loss |
| Importance of exercise in the weight-loss process |
| Risks and outcomes of laparoscopic versus open procedures |
| Surgical risks of bariatric surgery |
| Late complications after bariatric surgery |
| The importance of nutritional follow-up |

Preparation to have a successful outcome. The goals of the preoperative assessment are as follow:

• Determine that the patient is an appropriate candidate for surgical treatment.
• Identify factors that increase the surgical risk and intervene when possible to reduce risk.
• Identify and rectify potential barriers to long-term weight-loss success.

Patient Education and Informed Consent

Surgical treatment for severe obesity is indicated for individuals with a body mass index (BMI) of no less than 40 kg/m². Patients eligible for surgical treatment are those who have failed conventional weight-control programs. Individuals with a BMI between 35 and 39.9 kg/m² who have high-risk health problems such as sleep apnea or diabetes, or those with physical disabilities affecting lifestyle (ie, employment or mobility) are also candidates for surgical treatment. Contraindications to surgical obesity treatment include severe mental illness resulting in psychosis, substance abuse, and major organ failure. Patient education is an important aspect of the preoperative screening and evaluation process. The requirement for active lifestyle changes and alterations to eating behavior imposed by bariatric surgery make it essential that candidates have a thorough understanding of all aspects of their surgery and mechanisms of weight loss to avoid major complications. Patients referred for bariatric surgery are now better informed because of the increased numbers of surgical patients in the community, the media’s focus on bariatric surgery, and the extensive information available on the Internet.

Patients should understand the rationale for surgical treatment for severe obesity. It is an awareness of the significant health risks and poor quality of life associated with morbid obesity, and the low probability of achieving meaningful weight loss using any nonsurgical treatment. Additional information that should be covered with prospective patients is listed in Table 1.

The vital importance of multidisciplinary involvement in obesity management has been stressed for many years. Bariatric surgery programs should provide multidisciplinary services to optimally prepare patients for safe surgery, to appropriately decrease medications during postsurgical weight loss, and to ensure nutritional safety during weight loss and weight maintenance.

Behavioral Evaluation

There are currently no uniform guidelines for the behavioral evaluation of bariatric surgery candidates. Most studies indicate that the prevalence of psychiatric disease is as high as 50% with many patients taking psychotropic medications that may exacerbate the obesity. It remains unclear which comes first—the psychiatric disease contributing to the obesity or the obesity causing secondary psychopathology—or if it is a combination of both.

Frequent psychiatric diagnoses encountered in these patients include social phobia, somatization, obsessive-compulsive disorder, substance abuse, binge-eating disorder, night-eating syndrome, post-traumatic stress disorder, anxiety disorder, and depression. Despite the lack of uniform guidelines, most Centers of Excellence in bariatric surgery mandate a detailed behavioral evaluation for all preoperative patients. Despite the frequency of psychopathology, the vast majority of patients will be cleared for surgery and about 20% of patients are deemed unfit for immediate surgery without initial mental health treatment. Only a small number of patients will be deemed unfit for surgery for mental health reasons.

Absolute contraindications for surgery should include substance abuse; uncontrolled psychosis; alcoholism; and impaired intelligence, which prevents a complete informed consent process. Factors that may adversely influence long-term surgical weight loss include serious psychiatric conditions that require hospitalization and psychological stress that has contributed to obesity. Most mental health problems do improve after surgical weight loss, especially if they are secondary to obesity.

Surgical Risk Assessment

The indications and guidelines for surgical treatment of morbid obesity are based on a surgical mortality of 0.5% to 1.5%. Most recent reports of outcomes following bariatric surgery indicate that these desired outcomes
are being achieved. However, several recent reports from administrative databases indicate that the community mortality may be higher than that suggested by the peer-reviewed literature. 

During the past few years, some studies of large numbers of patients undergoing bariatric surgery have been published with outcome analysis and review of risk factors for complications and mortality. From these studies, older age, a high BMI, and male gender have been confirmed as proven surgical risk factors. Other factors that have been shown to increase mortality risk include hypertension, postoperative leak, and thromboembolism.

There are little data available concerning the role of comorbid illness as a contributor to surgical risk. A large study in medically obese subjects indicates that body weight does affect the obesity comorbid disease burden. Jamal studied 1,465 patients who underwent bariatric surgery and divided them into 2 groups according to the presence of “major” or “minor” comorbid diseases. (Major diseases include at least 1 of the following: hypertension, diabetes, venous stasis disease, pseudotumor cerebri, sleep apnea, obesity hypoventilation; minor means there are no major comorbid diseases.) Those with major comorbid diseases had a higher BMI (35±8 vs 32±6, P<0.001), a higher mortality (2.3% vs 0.2%, P<0.0032), a greater leak rate (4.1% vs 1.2%, P<0.0032), and a higher rate of surgical site infections (3.9% vs 1.4%, P<0.0133).

Benotti reviewed 1,210 consecutive patients undergoing surgical consultation for bariatric surgery. The mean age is 42±11 years with a male–female ratio of 25%:75% and a mean BMI of 50±10 kg/m². The comorbid disease prevalence is listed in Table 2.

In this study, increasing prevalence of major comorbidities and the total number of comorbid diseases was statistically related to increasing age and BMI. A similar statistical relationship for total comorbidities and comorbidity prevalence was demonstrated for males. Using BMI, age, and gender as independent variables, a multiple logistic regression model established that males (P=0.021), those with higher BMI (P<0.0001), and those of older age (P<0.0001) tended to have more comorbid illness. These data suggest that age, male gender, and extent of obesity are risk factors because they are markers for sicker patients.

Bariatric surgeons should know the extreme risks of surgery when performed on severely obese patients with limited cardiopulmonary reserve. Gallagher et al compared measurements of cardiorespiratory fitness in 43 patients with morbid obesity, 235 patients with established congestive heart failure, and age-matched controls. In this study, the morbidly obese subjects had a mean maximal oxygen uptake that was similar to patients with severe heart failure (mean ejection fraction 21.5±8%).

In a follow-up study, the same investigators studied cardiorespiratory fitness in 109 patients prior to laparoscopic gastric bypass. They found that severe complications and mortality were more common in patients whose maximum oxygen uptake was less than 15.8 mL/kg per minute than in those whose maximum oxygen uptake was more than 15.8 mL/kg per minute (P=0.02). Additionally, hospital lengths of stay (LOS) and 30-day readmission rates were highest in patients who were in the lowest tertary of peak oxygen consumption. This may be a promising way to identify high-risk patients and perhaps monitor their preoperative progress.

The critical importance of a detailed health exam by the bariatric surgical team cannot be overemphasized.
Many patients with severe obesity have suboptimal healthcare related to many factors, including access/denial, lack of physician concern, and limited physician awareness of the obese patient’s potential health problems. The surgical team will discover new or poorly managed comorbid conditions in many patients. The goal of the preoperative medical evaluation should be to discover and control all conditions relevant to the perioperative period.

**Pulmonary**

Respiratory problems are common in potential bariatric surgery patients. Most morbidly obese patients have some degree of dyspnea with exertion and many have significant impairment of pulmonary function, often with few symptoms. Changes in pulmonary function associated with obesity are listed in Table 3. Reduction in lung volume is the physiologic parameter that has the greatest clinical significance because of its association with atelectasis, airway closure, and hypoxia. Additionally, the magnitude of reduction in functional residual capacity is directly related to the rapidity of desaturation during apnea at anesthesia induction.

**Table 3. Changes in Pulmonary Function Associated With Obesity**

| Reduced compliance of lung and chest wall |
| Reduced lung volumes                        |
| Increased respiratory resistance            |
| Increased work of breathing                 |

Recent study of pulmonary function in morbidly obese patients indicates that forced vital capacity varies inversely with BMI, and patients with a very high BMI, even when asymptomatic, will have major reductions in lung function. Preoperative pulmonary function tests are indicated for those patients with documented pulmonary problems, for those with limited performance status because of dyspnea, and for patients with BMI of 60 or more. Pulmonary function studies and assessment of arterial blood gas will identify patients at risk for postoperative hypoxia, and will facilitate the postoperative respiratory care. It is also important to check for occult hypoventilation in severely obese patients. When arterial blood gas data are not available, an elevated bicarbonate level on the electrolyte panel may be an indicator of chronic hypercapnia.

The postoperative temporary reduction in lung function that follows upper abdominal and thoracic surgery is referred to as postoperative pulmonary restriction syndrome. Postoperative lung volumes and pulmonary function is reduced by about 50% after open bariatric surgery and by about 40% after minimally invasive bariatric procedures. The nadir of postoperative lung function occurs in the first 24 hours after surgery. Patients with significant pulmonary impairment preoperatively will be at significant risk for dangerous hypoxia during the immediate postoperative period. Identifying patients with reduced lung volumes preoperatively will facilitate respiratory care postextubation as the use of continuous bilevel positive airway pressure by nasal mask starting in the recovery room will preserve oxygenation and modify the temporary reduction in lung function in the immediate postoperative period.

Smoking is a proven risk factor for postoperative pulmonary complications. This risk declines with cessation of smoking for 8 weeks before surgery. This has not been critically evaluated in bariatric surgery, but most programs insist on abstinence from smoking beforehand. It should be made clear to patients and families that this cessation of smoking before surgery will reduce the risk of severe respiratory complications, and that failure to comply will result in unnecessary serious risks. Many patients who stop smoking in preparation for bariatric surgery do not return to smoking after surgery.

**Sleep Apnea**

Recent data indicate that more than 75% of bariatric surgery candidates have obstructive sleep apnea (OSA) and that prevalence increases with BMI. Central obesity, particularly involving the neck, carries the greatest risk of OSA. It should be investigated in all patients at least by detailed clinical history. Symptoms include heavy snoring, witnessed apnea, excessive daytime somnolence, and lack of restful sleep. Clinical consequences of OSA include hypoxemia, hypercapnia, pulmonary and systemic vasoconstriction, secondary polycythemia, and arrhythmia. Hypoxic pulmonary vasoconstriction can lead to right-heart failure.

The presence of OSA results in additional risks of hypoxemia and mandates special attention to perioperative narcotic and airway management by the anesthesiologist and surgeon. Untreated or inadequately treated OSA is associated with a higher incidence of perioperative complications. Patients suspected of OSA should be referred for preoperative sleep study and titration of continuous positive airway pressure (CPAP). The preoperative use of CPAP will reduce severe hypoxemia and associated pulmonary vasoconstriction, resulting in improved right ventricular function. Patients with OSA should bring their CPAP machines to the hospital for use in the postoperative period. CPAP with supplemental oxygen is
started immediately after extubation and used continuously with brief rest periods until the first postoperative morning. It is subsequently used only during sleep until discharge.

**Heart**

Cardiac dysfunction of varying degrees is common in the morbidly obese. Cardiac abnormalities associated with morbid obesity include cardiomyopathy, increased preload, diastolic dysfunction, and rarely, frank systolic dysfunction in association with cardiomyopathy. Cardiac evaluation is indicated for patients whose performance status is limited by exertional dyspnea, for those with OSA and hypertension, for those with fluid retention complicating super morbid obesity, and for those with symptoms of cardiac ischemia. Cardiac evaluation should allow optimum control of systemic hypertension, and for possible pulmonary hypertension, congestive heart failure, and ischemic heart disease. The increased incidence of sudden and unexplained death in morbid obesity may be a manifestation of occult cardiovascular disease in this population.

**Endocrine**

Approximately 15% to 20% of morbidly obese patients have type 2 diabetes. Glucose control in these patients requires close preoperative attention. The association between diabetes and SSIs is well known. Hyperglycemia (>220 mg%) inhibits many important functions of polymorphonuclear leukocytes. Recent evidence indicates that aggressive control of hyperglycemia during the perioperative period will reduce this infection risk. Additionally, others have confirmed that good preoperative glycemic control in terms of HbA1C below 7% is associated with a reduced infection risk across many surgical procedures. Preoperative patients and their families should be advised that proper glucose control is a preoperative requirement and that surgery should be scheduled only when this is achieved. If necessary, specialist consultation for adjustment of medications will be necessary. When medication adjustment is not successful, a reduction in carbohydrate intake will be necessary to keep glucose levels below 200 mg% and 220 mg%. Glucose control in the perioperative period is now an integral part of all surgical site infection prevention strategies.

Rare endocrine causes of obesity include hypothyroidism and Cushing’s syndrome. Preoperative patients who have not had recent thyroid function evaluation should. Adrenal function should be investigated if the patient demonstrates any symptoms or signs of Cushing’s syndrome, which include hypertension, diabetes, central obesity, weakness, muscle atrophy, hirsutism, striae, osteoporosis, and acne.

**Gastrointestinal**

Gastroesophageal reflux symptoms occur in 20% of morbidly obese patients. Those preoperative patients who complain of significant reflux symptoms should be referred for endoscopic foregut evaluation if this has not been done previously. Many bariatric surgeons feel that endoscopy on these patients should be routinely provided by the surgical team as a part of the preoperative evaluation. Schirmer reported 536 bariatric patients who underwent endoscopy prior to surgery. Endoscopic findings changed or altered the surgical procedure in 4.9% and *Helicobacter pylori* was found in 30%. Preoperative treatment of *H. pylori* was associated with fewer later marginal ulcers as compared with historical controls. Endoscopic diagnoses found include Barrett’s esophagus, esophagitis, gastritis, hiatus hernia, gastric or duodenal ulcer, and gastric polyps. In some patients, preoperative endoscopic findings may indicate that gastrostomy should be performed in addition to the bariatric procedure to facilitate future access to the excluded stomach for diagnostic or therapeutic purposes.

Obesity and weight cycling are risk factors for the development of cholelithiasis. Cholelithiasis is found in 15% to 20% of morbidly obese patients who are being prepared for obesity surgery. When cholelithiasis is documented preoperatively, cholecystectomy should be considered at the time of bariatric surgery because of the likelihood of biliary symptoms developing during the postoperative period of weight loss. The surgical team must decide how best to manage cholelithiasis at the time of bariatric surgery because the change in foregut anatomy will preclude postoperative endoscopic access to the periampullary region. For patients without gallstones, the use of agents to increase cholesterol solubility in bile has been shown to reduce the incidence of gallstone formation during the postoperative period of rapid weight loss. Mild abnormalities of liver function are common in morbid obesity. Elevation of alanine aminotransferase is the most common finding. The major cause for this is varying degrees nonalcoholic steatohepatitis.

**Special Management of High-Risk Patients**

In a small subset of patients, the preoperative workup identifies major risk factors that are associated with unacceptable mortality and major complication risks if they are not addressed. The patients at greatest risk are older super-obese patients, especially men with abdominal obesity, OSA, and limited cardiopulmonary reserve. Although these are the patients who benefit most from surgical weight loss, the risks may be very high. Optimal management of such patients remains an area of controversy. Strategies to reduce risk include mandating preoperative weight loss, use of the gastric balloon for preoperative weight loss, and staged surgical procedures.

Preoperative weight loss has been encouraged in our bariatric surgery program since its inception. The rationale for preoperative weight loss is based on the
observations that modest weight loss in high-risk obese patients will lower blood pressure, induce spontaneous diuresis, improve glycemic control, and reduce thrombosis risk. We recently reviewed our results with preoperative weight loss in 884 consecutive bariatric patients having surgery between 2002 and 2006. The average BMI at entry into the program was 51±8 kg/m². All patients were encouraged to lose 10% of excess body weight before the surgery. The preoperative weight loss for the cohort is summarized in Table 4.

The follow-up period for the study is 12±8 months. For a surgical weight loss of 40% of excess body weight and 70% of excess body weight, the patients who lost at least 10% of excess weight preoperatively reached the target weight sooner. The hazard ratios suggest that the probability of reaching 70% excess weight loss is higher for those who lost more than 10% of excess weight preoperatively. The most impressive finding in this study was that those who lost weight preoperatively were less likely (P=0.034) to have a hospital LOS longer than 4 days at the time of bariatric surgery (Still C et al, unpublished data, 2007). The major determinant of LOS after bariatric surgery is morbidity, and these patients are being retrospectively reviewed for a better understanding of the LOS implications on preoperative weight loss.

Preoperative weight loss strategies for high-risk bariatric surgery patients should be a part of the multidisciplinary care plan for all bariatric surgery programs. Additional studies are necessary to corroborate these preliminary findings. Most patients will be willing to cooperate with preoperative weight reduction if they are made aware that it will reduce serious risks.

The success of any bariatric surgery program is measured by surgical outcomes. Surgical outcomes traditionally are equated with 30-day mortality and morbidity data. In bariatric surgery, a good result includes an operation performed with a mortality of less than 1% and a life-threatening complication rate of less than 3%. An important part of the total care of postoperative patients includes nutritional counseling and surveillance to ensure nutritional safety of the weight loss and the correct food choices. Finally, a major aspect of a good surgical outcome involves prompt recognition and treatment of late surgical and nutritional complications. The preoperative evaluation process is a critical part of the foundation of a good surgical result. During this time, patients develop confidence in the bariatric surgery program, as they encounter professionals who are committed to comprehensive obesity management and sympathetic to their health and quality-of-life issues. The attention and support that patients perceive during the busy preoperative preparation establishes a trust that favorably influences patient understanding, satisfaction, learning, and participation in necessary follow-up.

Table 4. Weight Loss Achieved in 884 Patients Prior to Bariatric Surgery

<table>
<thead>
<tr>
<th>Preoperative Weight Loss (N=884)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;10% excess body weight loss:</td>
<td>425</td>
</tr>
<tr>
<td>5%-10% excess body weight loss:</td>
<td>169</td>
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<tr>
<td>0-5% excess body weight loss:</td>
<td>137</td>
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<tr>
<td>0-5% excess body weight gain:</td>
<td>86</td>
</tr>
<tr>
<td>&gt;5% excess body weight gain:</td>
<td>67</td>
</tr>
</tbody>
</table>
References


Dr. Benotti has no relevant financial information to disclose.
Approximately 300,000 deaths resulting from obesity are estimated to occur each year in the United States, according to the American Obesity Association. Hypertension, type 2 diabetes, high cholesterol levels, heart disease, cerebral vascular attack, gallbladder disease, fatty liver disease, osteoarthritis, gastroesophageal reflux, sleep apnea, and infertility are among the many health risks associated with obesity.

Although the healthcare community has long recognized a clear connection between obesity and many devastating health conditions, it has taken a number of years for insurance carriers to acknowledge obesity as a disease entity. The National Institutes of Health defines obesity as a body mass index (BMI) of 30 kg/m² or greater in an adult (Table 1). Thus, BMI is a crucial element that must be considered and recorded on all bariatric surgery claims.

Centers for Medicare & Medicaid Services Recognizes Obesity as a Disease

The Centers for Medicare & Medicaid Services (CMS) has long been the benchmark for reimbursement rates. Preferred provider organizations (PPO), health management organizations (HMO), and private insurance providers all take their cue from CMS when setting reimbursement policies and guidelines. Prior to February 21, 2006, the gastric bypass procedure was the only bariatric surgery covered by Medicare, and it was covered only on a case-by-case basis because obesity was not yet considered a disease entity. Since that date, however, CMS has acknowledged obesity as a disease by allowing national coverage for the Roux-en-Y gastric bypass (open and laparoscopic) as well as laparoscopic adjustable gastric banding and biliopancreatic diversion with duodenal switch (open and laparoscopic) (Tables 2 and 3). Although some insurance providers are still hesitant to reimburse for bariatric procedures for morbid obesity (BMI of >40 kg/m²), the solid policy advocated by CMS has led many insurance carriers to accept bariatric surgery as a definite option in preventive care for morbid obesity.
Table 1. Body Mass Index Chart

<table>
<thead>
<tr>
<th>BMI</th>
<th>Height</th>
<th>Weight, pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>4'10&quot;</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>5'0&quot;</td>
<td>128</td>
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<td>30</td>
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<td>311</td>
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<tr>
<td></td>
<td>6'4&quot;</td>
<td>328</td>
</tr>
</tbody>
</table>

BMI, body mass index

Based on reference 1.

Consequently, this will afford patients greater access to the care they need.

Some Procedures Still Not Covered

Some bariatric procedures still are not covered for Medicare patients, including vertical banded gastropasty (open and laparoscopic), sleeve gastrectomy (open and laparoscopic), and open adjustable gastric banding. At this time, Medicare does not consider these procedures to be as beneficial to patients because they are considered investigational because there is a lack of long-term data.

CMS Requirements

A facility must be recognized as a Center of Excellence by Medicare to receive reimbursement for obesity-related bariatric surgery. According to CMS, institutions must meet the standards set forth by the American Society for Bariatric Surgery (ASBS) Centers of Excellence and the American College of Surgeons Surgical Review Corporation (SCR). Facilities must show documented proof that they have the resources to perform safe bariatric surgery and that they have excellent short- and long-term outcomes. These indices, therefore, not only document process (ie, equipment, supplies, training of surgeons, and the availability of consultant services), but also emphasize results. This then relates to physicians with a higher level of expertise, which translates to a higher standard of care leading to more beneficial results for the bariatric patient. This policy was put into effect on February 15, 2006. A list of the CMS-approved ASBS
Table 2. CMS Nationally Covered Procedures

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Description of Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>43644</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and Roux-en-Y gastroenterostomy (roux limb ≤150 cm)</td>
</tr>
<tr>
<td>43645</td>
<td>With gastric bypass and small intestine reconstruction to limit absorption</td>
</tr>
<tr>
<td>43845</td>
<td>Gastric restrictive procedure with partial gastrectomy pylorus-preserving duodenileostomy and ileoilostomy (50- to 100-cm common channel) to limit absorption (biliopancreatic diversion with duodenal switch) (Do not report 43845 in conjunction with 43633, 43847, 44130, 49000)</td>
</tr>
<tr>
<td>43846</td>
<td>Gastric restrictive procedure, with gastric bypass for morbid obesity; with short limb (150 cm or less) Roux-en-Y gastroenterostomy (for &gt;150 cm, use 43847)</td>
</tr>
<tr>
<td>43847</td>
<td>With small intestine reconstruction to limit absorption</td>
</tr>
</tbody>
</table>

CMS, Centers for Medicare & Medicaid Services
Based on references 2 and 3.

Table 3. CMS Nationally Covered Procedures: New 2006 CPT Codes

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Description of Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>43770</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; placement of adjustable gastric band (gastric band and subcutaneous port components)</td>
</tr>
<tr>
<td>43771</td>
<td>Revision of adjustable gastric band component only</td>
</tr>
<tr>
<td>43772</td>
<td>Removal of adjustable gastric band component only</td>
</tr>
<tr>
<td>43773</td>
<td>Removal and replacement of adjustable gastric band component only</td>
</tr>
<tr>
<td>43774</td>
<td>Removal of adjustable gastric band and subcutaneous port components</td>
</tr>
</tbody>
</table>

CMS, Centers for Medicare & Medicaid Services; CPT, Current Procedural Terminology
Based on references 2 and 3.
reflecting the increasing prevalence of childhood obesity, in 2007 new V codes were also introduced for pediatric BMI. Age-specific bariatric surgery diagnostic codes may be added in 2008.

**Conclusion**

As coverage of bariatric surgery for morbid obesity becomes more prevalent, accurate coding and optimal reimbursement will also become more intricate, with the introduction of specialized ever-evolving codes. It is important to be familiar with these evolving codes and the documentation (Tables 5 and 6) required for reimbursement.

**References**

2. CMS Manual System, Publication 100-04 Medicare Claims Processing, Department of Health and Human Services (DHHS), Centers for Medicare and Medicaid Services (CMS); April 28, 2006.

Mrs. Prince and Dr. Rosenthal have no relevant financial information to disclose.

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**Table 4. Diagnostic and V Codes For BMI: New ICD 9 Codes**

<table>
<thead>
<tr>
<th>V Code</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>V85.35</td>
<td>BMI 35-35.9, adult</td>
</tr>
<tr>
<td>V85.36</td>
<td>BMI 36-36.9, adult</td>
</tr>
<tr>
<td>V85.37</td>
<td>BMI 37-37.9, adult</td>
</tr>
<tr>
<td>V85.38</td>
<td>BMI 38-38.9, adult</td>
</tr>
<tr>
<td>V85.39</td>
<td>BMI 39-39.9, adult</td>
</tr>
<tr>
<td>V85.4</td>
<td>BMI ≥40, adult</td>
</tr>
<tr>
<td>278.01</td>
<td>Morbid obesity</td>
</tr>
<tr>
<td></td>
<td>Severe obesity</td>
</tr>
<tr>
<td></td>
<td>Defined as: BMI between 30 and 39.9</td>
</tr>
<tr>
<td></td>
<td>Defined as: Increased weight beyond limits of skeletal and physical requirements (125% or more over ideal body weight), as a result of excess fat in subcutaneous connective tissue</td>
</tr>
</tbody>
</table>

**Table 5. Checklist for Surgeon Documentation**

- Current weight and height
- Body mass index
- Comorbidity
- Past attempts for weight loss (specific programs or treatments)
- Plan for treatment of the patient

**Table 6. Checklist for Coding Documentation**

- Use code for specific bariatric procedure
- Use comorbidity as primary diagnostic code
- Use V code or 278.01 as secondary code
- All follow-up treatment related to the bariatric surgery within the global period is inclusive as part of the surgical package
Complications of Bariatric Surgery

As experience with laparoscopic bariatric surgery has increased over the last decade, complication and mortality rates have continually decreased. Despite this, many primary care physicians are still reluctant to refer patients who are severely obese for bariatric surgery. According to a survey presented at the 2006 American Society of Bariatric Surgeons (ASBS) meeting by Perlman et al, family physicians are wary of bariatric surgery because of perceived high morbidity and mortality.1 The survey found that primary care physicians still view bariatric surgery as very risky and may be providing their patients with outdated information regarding the risks and benefits of modern bariatric procedures.

Surgeons must critically review their own complication rates as part of the accreditation process to be designated as a Center of Excellence by the ASBS or the American College of Surgeons. Additionally, surgeons have a responsibility to educate referring physicians about the acceptably low rate of major complications associated with laparoscopic bariatric surgery. This article provides a brief review of the incidence, diagnosis, and management of complications after laparoscopic gastric bypass (LGB), laparoscopic adjustable gastric banding (LAGB), laparoscopic sleeve gastrectomy (LSG), and biliopancreatic diversion (BPD).

Laparoscopic Gastric Bypass

Early complications after LGB such as bleeding, anastomotic leak, deep venous thrombosis (DVT), and pulmonary embolism (PE) can have devastating consequences, and their prevention is key to a successful bariatric program. Later complications such as anastomotic stricture, marginal ulceration, bowel obstruction, and nutritional deficiencies should be recognized early to prevent long-term sequelae.

Bleeding

Bleeding complications occur in less than 4% of patients following LGB.2 Postoperative bleeding can occur from mesenteric or omental vessels, a staple line, or at an anastomosis. Occasionally, a clot can obstruct the gastrojejunostomy or jejunojejunostomy. Bleeding that occurs postoperatively at the gastrojejunostomy can be diagnosed and managed endoscopically. Endoscopic access to the jejunojejunostomy is possible, depending on the Roux limb length. Bleeding from the excluded gastric remnant can be more difficult to diagnose and treat because there is no direct endoscopic access to this lumen after gastric bypass. Laparoscopic-assisted transgastric endoscopy through the gastric remnant is an option if the site of bleeding is within the bypassed segment of the foregut. Techniques to decrease the incidence of
Anastomotic Leak

The anastomotic leak rate after laparoscopic Roux-en-Y gastric bypass (RYGB) ranges from 0% to 5% in large case series. If not contained or controlled with a drain (Figure 1), leakage from the gastrojejunal anastomosis can result in diffuse peritonitis. A technical failure at the anastomosis will often present in the early postoperative period with rapid clinical deterioration, but most leaks occur around postoperative days 3 to 5 and result from perforation of an ischemic area at the anastomosis or gastric pouch.

This complication often presents with subtle findings in the patient who is severely obese, and physical examination findings of peritonitis are difficult to elicit. In a recent series of more than 3,000 gastric bypass patients from 4 centers, the anastomotic leak rate (all anatomic sites) was 2.1%. The most common signs and symptoms of a leak were tachycardia (72%), fever (63%), and abdominal pain (54%). An upper gastrointestinal (GI) series was positive in 17 of 56 patients tested (30%) and computed tomography (CT) was positive in 28 of 50 patients tested (56%). Both studies were negative in 30% of patients with leaks.

Tachycardia is the most sensitive sign of an anastomotic leak, and a heart rate above 120 beats per minute should prompt an investigation even if the patient looks and feels well. Tachypnea or decreasing oxygen saturations can also signal early sepsis from a leak, and may be clinically indistinguishable from a PE.

Surgeons should maintain a low threshold for radiologic testing (Figure 2). If diagnostic tests are inconclusive and clinical suspicion for a leak is high, the patient should be returned to the operating room. Diagnostic laparoscopy is appropriate for the stable patient, but unstable patients should undergo a laparotomy, with repair of the leak (if possible) and wide drainage of the area. If CT scan or an upper GI study uncovers a contained leak in a clinically stable patient, nonoperative management with adequate drainage, bowel rest, and antibiotics may be appropriate.

Wound Infection

Wound infection after laparoscopic RYGB occurs less than 5% of the time in most series. In a pooled analysis of open and laparoscopic series, wound infections occurred in 97 of 3,258 laparoscopic cases (2.9%) compared with 34 wound infections in 513 open RYGB cases (6.6%; P<0.001). Laparoscopic port-site infections are typically easy to manage with a short course of antibiotics and wound care and, unlike wound complications after open surgery, port-site infections add little to overall morbidity for the patient. The laparoscopic approach eliminates the risk of wound dehiscence or evisceration.

Thromboembolism

Bariatric patients are clearly at higher risk for venous
thromboembolism (VTE) than most normal-weight surgical patients. Increasing body mass index (BMI) is predictive of higher VTE rates in patients undergoing abdominal operations, even with low-dose heparin prophylaxis, and obesity is an independent predictor of recurrent VTE. Obesity and the metabolic syndrome are associated with a procoagulant state (elevated levels of fibrinogen, factor VII, factor VIII, vonWillebrand factor, and plasminogen activator inhibitor). Although there are potentially increased risks of VTE with laparoscopic RYGB (decreased venous return during procedure) and the open approach (delayed ambulation), there are no studies demonstrating a difference in VTE rates with the different approaches. In large published series and pooled data, DVT and PE each occur in less than 1% of patients undergoing laparoscopic RYGB.

A published survey of bariatric surgeons found that more than 95% used routine DVT prophylaxis and 38% used a combination of 2 or more methods of prophylaxis. The American College of Chest Physicians (ACCP) does not provide specific recommendations for thromboprophylaxis in bariatric surgery patients. These patients should be considered high-risk general surgery patients; they should receive thromboprophylaxis according to the ACCP guidelines, with low-dose unfractionated heparin or low-molecular-weight heparin (grade 1A evidence), and leg compression devices if multiple risk factors are present (grade 1C). In a retrospective multicenter study evaluating different enoxaparin (Lovenox, Aventis) dosing regimens in 668 bariatric surgery patients, the overall PE rate was 0.9% and 1 DVT (0.1%) was reported. Fewer events occurred when prophylaxis was initiated in the hospital, and all events occurred after the cessation of thromboprophylaxis. This study emphasizes the need to consider extended prophylaxis in selected bariatric patients.

Although preoperative placement of inferior vena cava filters in high-risk bariatric patients is controversial, it should be considered in patients with known risk factors for fatal PE including venous stasis disease, obesity hypoventilation syndrome, BMI of 60 or more, prior thromboembolism, or a known hypercoagulable state.

**Anastomotic Strictures**

Strictures at the gastrojejunostomy occur 2% to 20% of the time after laparoscopic RYGB. This complication is largely dependent on surgeon experience and the technique used to create the anastomosis. The gastrojejunostomy can be hand sewn (lowest stricture rate), or created with a linear stapler, or a circular stapler (highest stricture rate). Larger studies in the literature (>100 patients) report stricture rates of less than 7%, and these series include all 3 techniques. Strictures typically present within the first 3 months after surgery with progressive nausea and vomiting after eating and drinking. Strictures can also be associated with marginal ulceration at the gastrojejunostomy, and patients may present with epigastric pain. The vast
majority of anastomotic strictures (85%) are managed with a single endoscopic dilation (Figure 3). Patients with very tight strictures may require a second, and rarely a third or fourth, dilation. Endoscopic stenting of refractory strictures may be an option for selected cases, but further data are necessary regarding the efficacy and durability of this approach.

**Marginal Ulcers**

Ulcers occur at the gastrojejunal anastomosis, often on the jejunal side (Figure 4), and may be associated with (or contribute to) an anastomotic stricture. Marginal ulcers may be related to tension or ischemia on the anastomosis and have also been associated with the presence of foreign material (staples or non-absorbable suture), nonsteroidal anti-inflammatory drug (NSAID) use, excessive acid exposure in the gastric pouch (gastrogastric fistula), and smoking. Patients with ulcers typically present with epigastric pain, vomiting, and bleeding or anemia. The incidence of marginal ulcer after laparoscopic RYGB ranges from 0.5% to 5% in published series.4,9,20-23 This complication is treated with acid-suppression therapy and abolishment of the offending agent (NSAID, tobacco, acid exposure). Anastomotic revision is rarely required for a refractory ulcer.

**Bowel Obstruction**

Bowel obstruction after RYGB can result from adhesive disease or internal hernias. Large individual series report bowel obstruction rates ranging from 1% to 10.5%.4,9,20-25 In a collective review of 10 large laparoscopic RYGB series, bowel obstruction occurred in 3% of patients compared with 2% in open RYGB (P=0.02).2 Fewer intra-abdominal adhesions form after laparoscopic surgery, presumably because of less tissue trauma and bowel manipulation; this may explain the higher incidence of internal hernias relative to adhesive obstructions after laparoscopic RYGB. Hernias can occur at the mesenteric defect of the jejunojejunostomy, between the mesocolon and the Roux limb, or at the mesocolic defect for retrocolic Roux limbs (Figure 5). To reduce the incidence of internal hernias, the mesenteric defects are carefully closed during the procedure. Patients with intermittent, crampy abdominal pain that occurs months to years after gastric bypass should be evaluated with CT imaging or a small bowel series to evaluate for internal hernia. Depending on the nature of the symptoms, patients should also be evaluated for symptomatic cholelithiasis and marginal ulcer with ultrasound and upper endoscopy. If all testing is negative and the pain persists, diagnostic laparoscopy is indicated to evaluate for an internal hernia.

**Nutritional Deficiencies**

Because the stomach and duodenum are bypassed, deficiencies of iron, vitamin B₁₂, and other micronutrients can occur after standard gastric bypass. Taking a single multivitamin tablet alone is not sufficient to
prevent iron and vitamin B₁₂ deficiencies after laparoscopic RYGB. Iron deficiency occurs in 13% to 52% of patients (2 to 5 years after surgery) despite supplementation with a multivitamin and iron. Vitamin B₁₂ deficiency occurs in up to one third of patients who are prescribed a multivitamin after surgery. To prevent these deficiencies, iron and vitamin B₁₂ supplements should be given routinely after gastric bypass. Vitamin and micronutrient levels should be measured annually and deficiencies treated with additional supplementation. Thiamine deficiency can occur in gastric bypass patients after a period of prolonged nausea and vomiting. Patients presenting with these symptoms should be given thiamine supplements (prior to glucose-containing fluids) to prevent Wernicke’s encephalopathy or other devastating neurologic sequelae.

Calcium absorption in the duodenum and jejunum and vitamin D absorption in the jejunum and ileum are impaired after RYGB as well. Resulting calcium deficiencies can occur in up to 10%, and 51%, respectively, and occur more frequently with long-limb gastric bypass. These deficiencies can lead to secondary hyperparathyroidism and can result in increased bone turnover and decreased bone mass. Routine calcium and vitamin D supplementation should be given to prevent these deficiencies.

Series reporting nutritional deficiencies after gastric bypass vary greatly in terms of vitamin supplementation regimens. A survey of 109 bariatric surgeons demonstrated prescription rates of 96% for multivitamins, 63% for iron, and 49% for vitamin B₁₂ after RYGB. Surveillance for deficiencies and patient compliance vary as well, although most bariatric surgeons recommend annual blood testing.

**Laparoscopic Adjustable Gastric Banding**

Overall, early postoperative complications occur in 1% to 12% of patients undergoing LAGB. Bleeding after LAGB is rare because there is limited dissection and no staple lines. Given that no anastomoses are formed during this procedure, there is no potential for an anastomotic leak. Iatrogenic bowel perforation during the procedure occurs in 0.5% of cases. Rates of wound infection are similar to those seen with laparoscopic RYGB and, like other laparoscopic wound infections, those with LAGB are easily managed with minimal morbidity. The risk of DVT or PE after LAGB is lower than that seen after bariatric procedures (0.1%), and this may be related to patient selection or shorter operative times.

**Band-Related Complications**

Band-related complications can occur in the early postoperative period or years after the procedure. The placement of a silicone prosthesis in the abdomen carries with it a unique set of mechanical complications not seen with other bariatric procedures. Tubing or port problems requiring operative revision can occur in up to 11% of patients.

**Figure 4. Ulceration of the jejunum at the gastrojejunostomy.**

**Figure 5. Obstruction of a retrocolic Roux limb at the level of the transverse mesocolon.** Computed tomography shows 3 dilated loops of the Roux limb with a clear transition point (T). At surgery, the patient had transmesocolic herniation of the Roux limb with obstruction.

**Prolapse**

Prolapse of the stomach through the band can occur anteriorly (Figure 6), posteriorly, or symmetrically. Posterior prolapse is more common when the band is placed with the perigastric technique, and anterior prolapse is associated with the pars flaccida technique. Whether symmetrical pouch enlargement represents circumferential prolapse of the stomach through the band or chronic pouch dilation due to overeating or an overtight band is a topic of debate. Symptoms associated with prolapse include new onset gastroesophageal
reflux, progressive food intolerance, dysphagia, and regurgitation. The diagnosis is made with an upper GI series and, less commonly, endoscopy. Once this complication is recognized, fluid should be removed from the band. A small prolapse with minimal symptoms may initially be managed with band deflation and close observation. Surgical correction is usually necessary, however, and this involves reduction of the prolapsed stomach below the band and re-plication. Replacement of the band may be necessary if reduction of the prolapse is unsuccessful. Symmetrical prolapse (Figure 7) can be managed with band deflation and repositioning of the band above the previous site. Concomitant hiatal hernia repair (if present) should be performed to decrease the chances of recurrence.

**Erosion**

Erosion of the band is related to an overtight anterior or plication or plication of the stomach over the buckle of the band. This complication may present with recurrent port infections, abdominal pain, gastroesophageal reflux, or a change in the patient’s sensation of band tightness (increased or decreased restriction after eating). The diagnosis is made endoscopically, and treatment includes laparoscopic removal of the band and closure of the gastric perforation. Endoscopic removal of an eroded band has also been reported.

In a systematic review of the international literature that included 64 studies and 8,504 patients, Chapman et al reported tube or port malfunction requiring reoperation in 1.7% of cases, band erosion into the gastric lumen in 0.6%, and pouch dilation or band slippage in 5.6% of patients. Overall, complications requiring reoperation can occur up to 18% of the time, but complications have decreased as experience has increased with this procedure. In a series of 1,120 patients, O’Brien and Dixon reported a low incidence of early major complications (1.5%) but higher rates of late complications. Prolapse occurred in 25% and erosion occurred in 3% of their first 500 patients. In their last 600 patients, prolapse occurred in 4.7% of patients, and there were no erosions.

Another potential long-term complication of LAGB is esophageal dilatation. This may be secondary to an overtight band or a prolapse. The initial FDA trials A and B in the United States reported esophageal dilation rates of 10% and 6%, respectively. Kothari and colleagues reported a high band explantation rate (50%) among 36 patients with laparoscopic bands; 30% of patients who required band removal had esophageal dilatation. Larger, more recent series in the United States, Europe, and Australia have reported a lower incidence (<5%) of clinically significant esophageal dilatation. This problem remains a concern, however, and there are little data on the long-term effects of the LAGB on esophageal motility.

**Laparoscopic Sleeve Gastrectomy**

LSG involves resecting 75% to 80% of the stomach, leaving a narrow tubular stomach along the lesser
curvature. This restrictive operation is most commonly used as a first-stage procedure for high-risk patients or patients in whom RYGB or duodenal switch (DS) cannot be accomplished (massive hepatomegaly, severe adhesions, previous bowel resections, unstable intraoperative course). The use of LSG as a primary procedure is gaining popularity because of its excellent short-term weight loss and low complication rate. However, the durability of this procedure as a primary operation has not been established.

The largest series (n=126) of LSG performed in high-risk patients reported a 14% postoperative complication rate. Complications were 5 strictures, 2 leaks, 2 pulmonary embolisms, 5 cases of ventilator support for more than 24 hours, and 4 cases of renal insufficiency. In a series of 130 patients with BMI less than 50 who underwent LSG as a primary procedure, 5 patients (3.8%) had postoperative complications including 1 with leak, 1 with bleeding requiring reoperation, 1 with atelectasis, 1 with prolonged nausea and vomiting, and 1 who died 3 weeks after surgery as a result of abdominal sepsis.

**Malabsorptive Procedures**

BPD and BPD/DS are associated with higher complication rates than other bariatric procedures. This is, in part, a result of the complexity of these operations, particularly when they are performed laparoscopically. Additionally, BPD and BPD/DS are often performed on high risk patients with higher BMIs.

Marginal ulceration can occur up to 10% of the time, but this can be reduced to 1% to 3% with the DS and acid-suppression therapy. Long-term nutritional deficiencies are a major concern after malabsorptive operations. Protein-calorie malnutrition and anemia occur in up to 12% and 40% of patients, respectively. Vitamin B12 deficiency, hypocalcemia, fat-soluble vitamin deficiency, and bone demineralization also occur after BPD and BPD/DS.

In Scopinaro’s series of 1,968 patients who underwent BPD, the overall rate of early major surgical complications (intraperitoneal bleeding, wound dehiscence, wound infection, anastomotic leak, and gastric perforation) decreased from 2.7% in his first 738 cases to 1.4% in his last 500 cases. Late complications included anemia (5%), anastomotic ulcer (3%), incisional hernia (9%), and protein-calorie malnutrition (7%); 2% of patients required reoperation to elongate the common channel. Operative mortality decreased to 0.4% in the last half of the series.

In a series of 1,300 patients undergoing BPD/DS, Hess et al reported a 0.7% leak rate. Thirty-seven patients (3.7%) required revisional surgery, and 22 (2.2%) required lengthening of their common channel for excessive weight loss and protein deficiency. Five patients required lengthening of their alimentary channel for intractable diarrhea.

The feasibility of laparoscopic BPD and BPD/DS has been demonstrated in small series by surgeons highly experienced with the procedures. Complication rates are similar to open series in this early experience, with the exception of patients with a BMI greater than 65 who have a significantly higher complication rate.

**Mortality After Bariatric Surgery**

A report by the Agency for Healthcare Research and Quality released in January 2007 found that, among community hospitals performing all types of bariatric procedures, inpatient mortality decreased by 78% between 1998 and 2004, from 0.89% to 0.19%.

A meta-analysis by Buchwald et al analyzed outcomes for 22,094 bariatric patients in 136 studies and included restrictive, malabsorptive, and gastric bypass procedures (open and laparoscopic). The operative (30-day) mortality for gastric bypass in this study was 0.5%. In published laparoscopic RYGB series with more than 100 patients, the mortality rate is less than 1%. Overall, the mortality risk of LAGB is the lowest for any bariatric surgery performed today. In Buchwald’s meta-analysis, all restrictive procedures had an operative mortality rate (<30 days) of 0.1%. In a review of the international literature, Chapman et al reviewed the safety and efficacy of LAGB and compared it to vertical banded gastroplasty and RYGB. This review found an operative mortality of 0.05% for LAGB compared with 0.5% for RYGB. One perioperative mortality has been reported in the small number of LSG series to date. Published series of malabsorptive procedures typically report higher mortality rates than other bariatric procedures. Perioperative mortality among 3,030 patients who underwent BPD or BPD/DS was 1.1% in Buchwald’s meta-analysis. The perioperative mortality rate in Hess’s series of 1,300 patients who underwent BPD/DS was 0.6%.

**Conclusion**

Complications after bariatric surgery vary with the invasiveness of the procedure being performed. Overall, restrictive procedures have the lowest mortality rates. Although generally very safe, LAGB is associated with a unique set of short- and long-term complications that often require surgical correction. LSG appears to be a safe option for high-risk patients as a first-stage procedure. The rate of long-term complications, including weight regain, after LSG, is unknown. Few bariatric surgeons in the United States perform malabsorptive procedures. Although these procedures provide excellent long-term weight loss and comorbidity reduction, the complexity of the malabsorptive procedures, higher complication rates, and the potential for severe long-term nutritional problems have limited their widespread use. LGB is the most commonly performed bariatric procedure in the United States. Although this procedure can result in serious complications in a small percentage of patients, gastric bypass has a favorable risk–benefit ratio for the majority of patients seeking this operation.
References


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Bariatric surgery is the treatment of choice for the morbidly obese. With weight loss, many comorbid conditions are decreased or eliminated. Quality of life is generally increased and healthcare costs decrease. However, some patients regain more weight than would be expected, or even all of the lost weight within several years of surgery.

Long-term success of any bariatric procedure depends on the ability of the patient to make and sustain changes in eating and exercise patterns. Research tends to show a slow drift back toward presurgery habits from 6 months to 2 years after surgery. Psychological factors, such as stress and depression, also may impact a patient’s ability to sustain lifestyle changes. This article discusses reasons weight regain may occur from a psychological perspective and offers practical suggestions for reducing the impact of these psychological challenges (Tables 1 and 2).\textsuperscript{1-3}

**Disordered Eating Patterns**

Preoperatively, up to 30% of bariatric patients report engaging in binge eating, but reports widely vary.\textsuperscript{4-6} Binge eating is the act of consuming a much larger amount of food than other people in the same period of time, with the binge eater suffering from a loss of self-control. Bariatric surgery itself may limit the quantity of food consumed in any one sitting, and may limit hunger, but the compulsive eating aspect may still exist. Many patients hope the surgery will magically “cure” their preoccupation with food, but this is often not the case. Loss of control appears to reemerge approximately 6 months to 2 years after surgery. In such cases, the *Diagnostic and Statistical Manual of*
Mental Disorders Fourth Edition, Text Revision, diagnostic criteria for an eating disorder are not met, because the quantity of food eaten is not out of the norm, but the reemergence of loss of control is cause for concern in these patients. Hsu et al found that patients who exhibited preoperative disturbances in their eating pattern had worse outcomes following surgery. Although they experienced a short-term improvement, the eating improvement eroded after 2 years and there was subsequent weight regain.7 Kalarchian et al reported a connection between one’s loss of control over eating and weight regain after gastric bypass.8,9 In their study, 46% of patients experienced a recurrent loss of control and regained significantly more weight. The researchers suggested that clinical intervention that addresses this loss of control would benefit these patients. Mitchell et al also reported a reemergence of the loss of control in a study of patients who underwent gastric bypass.8 These patients had gained significantly more weight than controls at 2 years. Larsen et al suggested that identifying and treating patients who exhibit postoperative binge eating may be crucial to long-term success after bariatric surgery.10

Mitchell and de Zwann postulated that patients who were binge eaters before surgery were at higher risk of experiencing a loss of control after surgery, resulting in greater weight regain over time.5 The reasons for persistent loss of control are unclear at this time. It may be possible that patients are successful in losing weight in the short term because the drastic weight loss period after surgery is so reinforcing, both internally and externally, that they are able to overcome the binge-eating compulsion. Or perhaps the surgery is simply at its most restrictive during that initial phase. After 2 years, there is much less negative physical feedback (nausea, vomiting, dumping syndrome) and the capacity of the pouch left by the gastric bypass procedure has increased. Thus, the period of time directly following surgery when a patient does not yet feel that loss of control would be a useful target of future studies.

According to a report by the US Department of Health and Human Services, some patients regain weight after gastric bypass because they eat too many high-calorie soft foods that are able to easily pass through the narrowed gastric opening without causing discomfort, whereas others cannot alter their eating habits enough to lose a sufficient amount of weight.11

Saunders noted that some binge eaters often become “grazers” after surgery,12 a transition that often occurs approximately 6 months after surgery. Grazing may become a problem because of the ability to consume increased calories by filling the pouch more often than recommended. Brolin et al reported similar results.13 In another study, Saunders et al reported that a person with binge-eating disorder may begin to graze or snack after surgery, eventually leading to weight regain.14 To maintain weight loss,
patients must continue to eat smaller meals even if the size of their pouch enables them to consume larger amounts, and they must limit grazing. Saunders suggested that treatment for binge eating should be a mandatory part of the gastric bypass care regimen.12

It is strongly recommended that an experienced bariatric psychologist conduct presurgery clinical interviews, and that patients meeting criteria for binge eating be referred for psychotherapy. It is important to address the problem before surgery rather than waiting until after, when the outcome of the procedure is at risk. It may be helpful to conceptualize the first 6 to 24 months after surgery as a dormant period for the disorder. Many patients have reported that they hope the initial period of forced compliance will enable them to learn to control themselves, or they insist they would not risk surgery if they intended to revert to their old habits. This type of thinking is overly optimistic and unrealistic. Although some patients may be able to change on their own, most would benefit greatly from targeted individual therapy to change this behavior pattern. Long-term success will depend on a consistent program of healthy eating and regular exercise.11

**Psychiatric Comorbidities**

An important aspect of the presurgery psychological interview is to uncover potential psychiatric comorbidities that may influence long-term surgical outcome. The presence of such comorbidities is not necessarily a roadblock to bariatric surgery, but it should be revealed and addressed before the surgery.

It is well established that depression generally decreases with weight loss in this population15 because the weight itself is often the cause of depression.16 Wadden et al reported that patients considering bariatric surgery who have untreated major depressive disorder should receive psychiatric or psychological care before undergoing surgery.17 Depression presents extra challenges for patients trying to sustain the lifestyle changes needed after surgery and coping with the additional stress associated with the first few months after surgery. Patients with depression should receive therapy to decrease symptoms while they await surgery and monitoring postoperatively for any increase in symptoms.

Additionally, patients with a cluster B personality disorder that may include erratic, emotional, and dramatic traits may be at higher risk for binge eating, and this presentation constellation may be a risk factor for weight regain after bariatric surgery.5 It would be beneficial for these patients to receive therapy as well as education about the influence of personality traits on sustaining lifestyle changes.

A history of psychiatric hospitalizations has been linked to an increase in medical complications after surgery.18,19 Given the connection between psychiatric disorders and negative surgical outcome, preoperative psychotherapy to reduce symptoms is warranted in these patients.

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**Table 2. Specific Psychology Management Guidelines for Postoperative Bariatric Patients**

Because of the large numbers of patients seen in any bariatric practice, it is impractical for the psychologist to see all patients for individual therapy. Patients often are referred to an outside psychologist. It is strongly recommended that patients be referred for individual therapy before surgery if they have one or more of the problems listed below and these problems are identified early in the process. Otherwise, the long-term outcome of the surgery, and the patient's physical or mental health may be at risk.

1. Feelings of overwhelming stress. These patients may benefit from individualized stress management education, as well as assistance in resolving some of the stressors.

2. Eating disturbances such as a feeling of loss of self-control when eating, self-induced vomiting, or grazing.

3. Noncompliance with a consistent exercise routine, the bariatric diet, or the vitamin regimen.

4. Alcohol or drug abuse or smoking.

5. Emotional eating that impacts weight, or compulsive eating.

6. A psychiatric crisis, including mania, volatile mood swings, psychosis, severe withdrawal or inability to function in daily life, depression, and suicidal ideation. The trained psychologist may do an assessment of dangerousness, crisis intervention, and facilitate inpatient or outpatient treatment. Other treating professionals, such as outside therapists or psychiatrists, may be contacted for continuity of care.
Self-Induced Vomiting

Self-induced vomiting is a symptom that has obvious repercussions for health in the aftermath of bariatric surgery. In Sauder's 2004 study, 15% of patients reported purging (vomiting) to avoid regaining weight, with this behavior beginning to emerge 6 months or more after surgery. Many bariatric patients become proficient at vomiting and will know when the next bite will lead to vomiting. It is considered an eating disorder when the patient purposely takes the next bite knowing that it will lead to vomiting. Mitchell and de Zwaan found that 6.3% of their sample admitted to self-induced vomiting behavior to control weight postoperatively, and each of these patients met criteria for an eating disorder prior to surgery. Thus, every patient should be educated before surgery on the dangers of this behavior, and steps should be taken if they start to exhibit symptoms. Those with a preexisting eating disorder should be treated before surgery to prevent the catastrophic health ramifications that may occur after surgery.

Alcohol Abuse

Abuse of alcohol following the Roux-en-Y procedure is a new phenomenon being examined. Patient reports and focus in the media have brought this to light. Klockoff et al found a possible explanation. They found an approximately 50% higher blood alcohol level and a faster peak time in females who had undergone gastric bypass than in controls. Buffington found 90% of patients reported being more sensitive to alcohol after surgery than before, and she cited several examples of postoperative patients being arrested for driving under the influence of alcohol after surgery. Thus, every patient should be educated before surgery on the dangers of this behavior, and steps should be taken if they start to exhibit symptoms. Those with a preexisting eating disorder should be treated before surgery to prevent the catastrophic health ramifications that may occur after surgery.

Dichotomous Thinking

An “all-or-nothing” thinking pattern has been linked with weight regain in dieters. Patients also experience this thought pattern after bariatric surgery. Training in presurgery classes to avoid the unrealistic expectation of 100% perfection with diet is important because such expectations can set the patient up for failure. Relapse prevention is a very important component of education before surgery. It is important to advise patients to strive to do 95% of what is expected to avoid the black-and-white thinking that often leads to relapse. They should be advised that “falling off the wagon” is human nature, and they will need to monitor that for the rest of their lives. The problem is in the length of time it takes to get back on track. There is a vast difference between taking a couple of days rather than 6 months to resume healthy habits.

Role of Psychologists

Psychologists play an integral role in a comprehensive, multidisciplinary bariatric program. They can provide guidance in the overall psychology management of the program and can provide strategies to address specific problems that may arise.

Conclusion

Bariatric surgery can be a life-altering event and can offer many patients an increased quality of life. The long-term success of the surgery depends on the patient’s ability and willingness to indefinitely sustain the behavioral changes. Stress, depression, disordered eating patterns, and dichotomous thinking can impact a patient’s ability to sustain lifestyle changes and may lead to weight regain after surgery. Psychologists are an integral part of the management team because they are qualified to identify and treat these issues, assisting the patient in achieving long-term weight maintenance.
References


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Nutritional Deficiencies Following Bariatric Surgery

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Although bariatric surgery can aid patients in rapidly losing large amounts of unhealthy excess weight, nutritional complications that range from mild to severe can follow.

Introduction

Bariatric surgery is an effective tool for achieving durable weight loss and improving weight-related comorbidities with relatively low incidences of reported morbidity and mortality. Bariatric procedures induce weight loss by imparting restriction, malabsorption, or a combination of both. However, the caloric restriction and/or malabsorption that accompanies these weight-loss procedures can put patients at risk for developing significant nutritional deficiencies, that can lead to metabolic bone disease, neurologic abnormalities, and protein malnutrition. Some of these deficiencies can develop rapidly after surgery, and most worsen with time as body stores of nutrients and vitamins are depleted within 1 year of surgery. Ironically, given the perception that weight gain is related to overeating, therefore leading the obese individual to getting adequate nutrients, it has been reported that preoperative nutrient levels in many of these patients are suboptimal.

As more bariatric operations are performed, the potential increases for more patients to present with nutrient abnormalities. Therefore, healthcare practitioners must learn to recognize and treat the nutritional consequences of weight-loss operations, as well as know how to screen for and prevent deficiencies.

This chapter begins with the B vitamins and iron, of which most practitioners are aware for the potential of health concerns. Calcium and vitamin D is addressed next because of their effect on bone health. The other fat soluble vitamins—A, E and K—are then adduced, followed by the trace minerals that may be of concern postoperatively. Protein malnutrition is reviewed last.

The B Vitamins

The B vitamins are comprised of 8 essential nutrients. Levels have been analyzed in patients before and after weight-loss surgery. Reports show preoperative deficiencies of cyanocobalamin (vitamin B12), thiamine (vitamin B1), and pyridoxine (vitamin B6). All of these, along with folate (vitamin B9) and riboflavin (vitamin B2), have been shown to be low postoperatively.

Vitamin B12

Vitamin B12 deficiency is among the most common...
nutritional consequences of weight-loss surgery. Operations that limit stomach capacity significantly impair the body’s ability to absorb vitamin B12. Following bariatric surgery, the remaining smaller gastric pouch secretes less acid, which leads to incomplete release of vitamin B12, a food-bound vitamin. There is also less intrinsic factor—a protein produced by glands in the stomach lining—available to bind to the vitamin in the duodenum. Intrinsic factor and vitamin B12 form a complex that is later absorbed in the ileum. Also, many foods that are good sources of B12 may be difficult for the postoperative patient to tolerate, and are thus avoided (Table 1).

In 1 study, 5% of patients were found to be deficient in vitamin B12 preoperatively, whereas at least 3 other studies found levels were adequate. Postoperatively, deficiency is common after vitamin stores are depleted, at approximately the 1-year mark. Symptoms of deficiency include glossitis, weakness, depression, poor appetite, megaloblastic anemia, peripheral neuropathy, and ataxia. The amount of B12 in standard multivitamins is not adequate to prevent deficiency or elevated homocysteine levels. Because early deficiency may not be symptomatic, patients should undergo regular blood work and be proactively supplemented with crystalline B12 100 to 350 mcg daily. Treatments for deficiency can be given in many forms: oral crystalline tablets, sublingual preparations, intramuscular (IM) injections, and nasal sprays. One recommendation is 1,000 to 3,000 mcg of vitamin B12 given IM postoperatively and then repeated every 6 to 12 months.

**THIAMINE**

A variety of food sources contain significant amounts of thiamine (Table 1). Rice-based diets or diets high in other refined starches, or chronic alcohol consumption puts people at risk for developing thiamine deficiency, also known as beriberi. Bariatric surgery, malabsorption, and prolonged vomiting can further increase this risk. Low preoperative thiamine levels were found in 15.5% and 29% of patients presenting for obesity surgery at centers in Florida and New York, respectively. Beriberi may be more common in blacks and Hispanics than in whites.

Early thiamine deficiency produces fatigue, poor memory, anorexia, and abdominal discomfort. Wernicke-Korsakoff syndrome may present with eye changes, ataxia, confusion, and encephalopathy, which may lead to coma. Cardiac changes (“wet beriberi”) may be recognized as high cardiac output with vasodilation and warm extremities, which can lead to heart failure.

Neurological effects (“dry beriberi”) include paresthesias of the toes, burning in the feet, muscle cramps in the calves, and hyporeflexia. Thaisetthawatkul et al noted that 16% of patients undergoing bariatric surgery had peripheral neuropathy, which was positively correlated with the rate and amount of weight loss, reduced
serum albumin and transferrin, gastrointestinal complications, and attendance at a nutrition clinic. It should be noted that many other, more rare nutrient deficiencies—including vitamin E, vitamin B6, and copper—also cause neuropathies. It is unclear whether thiamine or another nutrient or combination of nutrients is responsible for the neuropathy seen after weight-loss surgery, which was recently termed acute postgastric reduction surgery neuropathy.78

Thiamine deficiency has been seen in patients following both restrictive and malabsorptive operations.29,30 Most reports are of young women following a period of prolonged vomiting about 4 to 12 weeks after surgery, likely because vitamin stores last approximately 3 to 6 weeks.11,20,31 Because postoperative dietary assessments show inadequate thiamine intake, a daily multivitamin containing thiamine is recommended.6,32 Treatment options include 50 to 100 mg I.V. or IM daily for 2 days followed by 20 mg orally for 2 weeks11,20,33 or 100 mg of thiamine, I.V. or IM, for 7 to 14 days followed by 10 mg orally daily.27 To treat encephalopathy, 100 mg I.V. every 8 hours has been recommended.28

FOLATE

Inadequate levels of folate may result from foods having less exposure to gastric acid and to the upper section of the small intestine after surgery. Folate is an essential component in metabolic pathways and is necessary to form DNA and red blood cells. Many patients undergoing bariatric surgery are women of childbearing age, thus folate deficiency can be especially concerning because of its correlation with neural tube birth defects.34,35 Other complications to note are megaloblastic anemia, peripheral neuropathy, restless leg syndrome, sore red tongue, confusion, and weakness. Low folate levels are not as prevalent as vitamin B6 and iron deficiencies.20 Multivitamin supplements appear adequate to prevent folate deficiencies.24,37 If detected, noncompliance with daily multivitamin supplements that contain 400 mcg of folic acid should be suspected. Folate deficiency can be easily treated with resumption of same.37

VITAMIN B6 AND RIBOFLAVIN

A few studies have examined the vitamin B6 and riboflavin status of bariatric surgery patients. Nutritionists are aware of health issues associated with deficiencies of these vitamins. Vitamin B6 deficiency may cause anemia, dermatitis, seizures, and neuropathies.5 Riboflavin deficiency may cause anemia, stomatitis, rash, and impaired growth. Boylan et al found preoperative vitamin B6 deficiency in 46% of patients.24 A second study concluded that postoperative vitamin B6 levels were insufficient in most patients despite taking a supplement containing 1.6 mg daily, which was the US Recommended Daily Allowance at the time of the study.32 (Note that the 2004 Dietary Reference Intake [DRI], still in use today, is actually lower, at 1.3 mg per day.) Other studies conclude that in the absence of prolonged vomiting, a supplement containing the DRI for vitamin B6 should be adequate for these patients.5,38 High-protein diets increase the need for vitamin B6.39 Also, there is evidence that supplementation of B6 may improve the symptoms of carpal tunnel syndrome.40

The limited data available on riboflavin seem to conclude that postoperative intakes may be inadequate, but like vitamin B6 and in the absence of protracted vomiting, supplementing with multivitamins that contain riboflavin should prevent tissue depletion.38

Iron

Iron deficiency and anemia are frequent concerns regarding pre- and postoperative bariatric surgery patients. The 3 most common causes for iron deficiency appear to be decreased absorption of iron due to bypass of the duodenum; less gastric acid, so iron is therefore not reduced to its more absorbable ferrous form; and lower iron intake from avoiding certain foods (Table 2). Iron is necessary for numerous oxidation-reduction reactions and as a means of oxygen transport in hemoglobin. Common symptoms of deficiency are fatigue, glossitis, stomatitis, and impaired temperature regulation (complaints of feeling cold). There have been reports of pica—strong cravings for non-nutritive substances such as ice or clay—after gastric bypass, which were treated with iron supplementation.41

There have been reports of preoperative iron deficiency ranging from 14% to 44% of patients.7,22 Studies show iron levels continuously decline after surgery. Iron deficiency does not appear to correlate with the amount of weight lost.4 Incidence as high as 74% have been reported following distal Roux-en-Y gastric

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<td><strong>Nutrient: Mineral</strong></td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Copper</td>
</tr>
<tr>
<td>Iron</td>
</tr>
<tr>
<td>Selenium</td>
</tr>
<tr>
<td>Zinc</td>
</tr>
</tbody>
</table>
Table 3. Suggested Nutritional Laboratory Analyses Prior to Weight Loss Surgery

| Vitamin A | Magnesium |
| Vitamin B12, folate | PTH (Intact) |
| Ceruloplasmin (copper) | PT/PTT |
| CBC | Selenium |
| Vitamin D25 total, fractionated D2 & D3 | Thiamine (vitamin B1) |
| Iron, TIBC, ferritin, transferrin | Zinc |

Table 4. Suggested Laboratory Analyses Following Weight-Loss Surgery (3 months, 6 months, 1 year, annually thereafter)

| ALT, albumin, ALP, AST, BUN, calcium, cholesterol, creatinine, Glucose, phosphorus, total protein, triglycerides |
| Vitamin A |
| Vitamin B12, folate | PTH (Intact) |
| Ceruloplasmin (copper) | PT/PTT |
| CBC | Selenium |
| Vitamin D25 total, fractionated D2 & D3 | Thiamine (vitamin B1) |
| Iron, TIBC, ferritin, transferrin | Zinc |

Calcium and Vitamin D

There are multiple reports of increased bone turnover and reduced bone mineral density following bariatric surgery. Calcium is absorbed in the duodenum and jejunum, vitamin D in the jejunum and ileum. The anatomical changes from surgery along with limited intake of dairy products due to intolerance can decrease both calcium and vitamin D absorption and intake. High-protein intakes also tend to increase urinary calcium excretion.

Vitamin D plays an essential role in calcium absorption. Deficiencies of vitamin D and calcium cause elevation of parathyroid hormone (PTH), which subsequently increases calcium resorption from bone. The exact etiology of deficiency in the obese is still unclear, but is affected by climate, wearing sunscreen and covering skin, and skin pigmentation because vitamin D is synthesized in the skin from sun exposure. Another explanation is decreased vitamin D bioavailability due to enhanced uptake and clearance by adipose tissue. Malabsorption of fat-soluble vitamins caused by the delayed mixing of bile and pancreatic enzymes with fat also contributes to lowering vitamin D levels postoperatively. Malabsorptive procedures such as biliopancreatic diversion (BPD) and duodenal switch (DS) carry a higher risk of metabolic bone disease.

It should be noted that vitamin D deficiencies and elevated PTH levels are seen both pre- and postoperatively. Buffington et al found 62% preoperative obese subjects vitamin D deficient, and Sanchez-Hernandez et al found that number was 69%. Additionally, there was a negative correlation between vitamin D levels and body mass. Postoperatively, there are reports of hypocalcemia, elevated alkaline phosphatase, PTH elevated, and N-telopeptide levels, and decreased bone density at the total hip, trochanter, and total body. Patients with early bone disease may present with fatigue, hypocalcemic tetany, arthralgia, and myalgia that can progress to osteomalacia, diffuse bone pain from microfractures and ultimately, spontaneous fractures.
Although there is universal support for supplementing both nutrients, there are mixed results as to whether supplementation leads to improvements in PTH levels or other bone markers. Weight loss independently causes bone loss. Daily supplementation to a level of 1,200 mg of calcium and 8 mcg of vitamin D (equivalent to 320 IU) or even 1,200 mg calcium and 800 IU, in addition to dietary sources, may not be sufficient protection. Riedt et al supplemented gastric bypass patients to a total intake of 1,800 mg of calcium daily and tested their calcium absorption. Calcium absorption decreased but remained within a normal range, whereas markers of bone resorption increased significantly after surgery. In the author’s New York City practice, patients often require daily therapy with 1,600 mg calcium and 2,400 IU vitamin D₃ (or 14,000 IU vitamin D₂) to suppress PTH levels (unpublished data). It is inconclusive as to whether gastric acid affects calcium absorption, yet most recommendations are for calcium supplements in the citrate form because its absorption is less affected by a low-acid environment.

### Other Fat-Soluble Vitamins: A, E and K

The mechanism whereby inadequate exposure of nutrients to biliopancreatic secretions imparts malabsorption is mentioned above. Malabsorption of fat and fat-soluble vitamins has significant nutritional consequences. There are at least 4 published accounts of vitamins A, K, and E deficiencies in the literature. Patients undergoing malabsorptive surgeries clearly raise more serious concerns than those whose operations impart merely restriction. Calculating fecal fat measurements in 10 DS and 9 RYGB patients, Gagner et al found DS patients excreted 81% of the fat they consumed—significantly more than the RYGB group. Hypovitaminosis A is most commonly linked with eye disease. In addition to night blindness, eye-related symptoms of vitamin A deficiency include xerophthalmia, Bitot’s spots, and keratomalacia. Skin signs include xerosis and petechiae. There are at least 4 accounts of postbariatric surgery night blindness. Treatments varied between oral vitamin A 10,000 IU daily; IM vitamin A 100,000 IU thrice daily; and IM vitamin A 300,000 IU twice weekly for 4 weeks along with oral vitamin A 100,000 IU daily (1 case study did not detail supplement dosing). Many multivitamins contain 3,500 to 5,000 IU of vitamin A, but this may be inadequate. Marceau et al suggest 25,000 IU daily for patients undergoing BPD and DS. A review of patients with BPD and DS in New York and Australia found inadequate serum vitamin A levels in 52% (n=46) after 1 year and 69% (n=28) after 4 years. In patients with distal RYGB, only 10% demonstrate deficiency. Less is known about vitamins K and E. Available data on the incidence of vitamin K deficiency show between 42% and 68% of patients are deficient after malabsorptive surgeries. Low levels of this vitamin alter clotting

### Table 5. Suggested Supplementation Following Weight-Loss Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Supplementation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roux-en-Y Gastric Bypass</strong></td>
<td>Calcium citrate 1,200 mg (with vitamin D)</td>
</tr>
<tr>
<td></td>
<td>Multivitamin*</td>
</tr>
<tr>
<td><strong>Laparoscopic Adjustable Gastric Band</strong></td>
<td>Calcium citrate 600-1,200 mg (with vitamin D)†</td>
</tr>
<tr>
<td></td>
<td>Multivitamin*</td>
</tr>
<tr>
<td><strong>Duodenal Switch</strong></td>
<td>Vitamin A 25,000 IU</td>
</tr>
<tr>
<td></td>
<td>Calcium citrate 1,200-1,600 mg</td>
</tr>
<tr>
<td></td>
<td>Vitamin D₃ 1,200 IU daily or vitamin D₂ 50,000 per week</td>
</tr>
<tr>
<td></td>
<td>Iron†</td>
</tr>
<tr>
<td></td>
<td>Multivitamin* 1-2</td>
</tr>
</tbody>
</table>

*Multivitamin should contain zinc and selenium
†Iron should contain vitamin B₁₂, vitamin C, and folic acid, or should be added separately
‡Men: 600 mg, women: 1,200 mg or based on individual intake of dairy
and increase bleeding tendency, which may present as excessive bruising or bleeding gums. One suggestion is to supplement vitamin K for international normalized ratio greater than 1:4.13

Reports of vitamin E deficiency rarely appear in patients who receive multivitamin supplements containing vitamin E. Low levels of this antioxidant vitamin have been associated with neurological abnormalities.6 Boylan et al found 23% of patients had marginal tocopherol levels preoperatively, and postoperatively, levels correlated with vitamin E supplement intake.24 More recently, Slater and Dolan found only 4% and 5% of patients, respectively, to be deficient.14,55 Most programs do not currently measure vitamin E levels.20

Zinc

Low zinc levels may be associated with hair loss, dermatitis, impaired immunity, and delayed wound healing. There is very little research relating zinc deficiency to hair changes following bariatric surgery. Situations that likely play a role in deficiency include the primary site of zinc absorption being bypassed in weight-loss operations that alter the gastrointestinal tract, a reduced intake of foods that provide good sources of zinc (Table 2), and increased stool losses via steatorrhea.

Preoperative zinc deficiency was reported in 5.2% to 16.7% of patients;66 postoperatively, reports are varied. Anywhere from 10.5% to 50% of malabsorptive surgery patients have been found to have low blood levels.14,55,66 Zinc blood levels alone are not considered an accurate measure of zinc status. A recent study analyzed plasma, erythrocyte, and urinary zinc levels after RYGB and found changes that might lead to long-term deficiency, as well as lower zinc intakes.18 The authors concluded that zinc supplementation is necessary beginning 2 months postoperatively in patients who present with normal levels preoperatively. They also recommended that zinc dietary intake, as well as plasma and urinary levels, should be monitored regularly after surgery. Another study correlated cessation of hair loss with supplementation of 200 mg zinc sulfate thrice daily, but blood levels were not checked in this report.67

Copper

Copper is a trace mineral that plays an essential role in the structure and function of the nervous system. Absorption is probably in the stomach and duodenum. Kumar reported a case of copper deficiency in a woman who had undergone gastric bypass surgery 12 years earlier. The patient presented with a 9-month history of progressive hand and leg parasthesia and unsteadiness. She had multiple nutrient deficiencies and was taking many supplements, including 150 mg of zinc daily. High-dose zinc supplementation interferes with copper bioavailability by increasing levels of a copper-binding protein that prevents copper absorption.34,68

Selenium

Selenium is an antioxidant mineral that is absorbed in the duodenum and works closely with vitamin E. There are very limited data on the importance of selenium after bariatric surgery, although there have been reports of both preoperative and postoperative deficiencies. Prior to RYGB and laparoscopic adjustable gastric band (LAGB), 6% and 6.3% of patients, respectively, had low selenium levels. One year following surgery, 7.7% of RYGB and 40% of LAGB patients were selenium deficient.66 Dolan et al reported selenium deficiency in 14.5% of patients following malabsorptive surgery.14

Protein

Considerable research has been devoted to the incidence and implications of protein malnutrition in bariatric surgery patients. Statistics vary widely on the percentage of affected patients. Hypoalbuminemia has been described ranging from 1.3% to 33% of patients. The variations may reflect largely on the surgical program’s degree of preoperative nutrition education and postoperative follow-up.12,15,16,69,70

Protein malnutrition is commonly precipitated by complications such as stricture, excessive vomiting, or what authors consider noncompliance. There is more frequent and more severe hypoalbuminemia in patients who undergo more malabsorptive procedures such as BPD and DS, but it can present after RYGB. In many cases, conventional treatment with nutritional counseling can be effective in reversing malnutrition. Helping patients increase their intake of protein via foods and liquid supplements so they are consuming 1.5 g/kg ideal body weight or 105 g of protein daily is often an effective intervention.12,70,71 Pancreatic enzymes can be used to counteract the effects of malabsorption. More aggressive treatments, such as i.V. nutrition (total parenteral nutrition) may be required.12 Ultimately, a small number of patients will require partial or total reversal of their surgeries to correct deficiencies.72

Conclusion

Although there are numerous benefits to the weight loss attributed to bariatric surgery, there is growing evidence that nutritional consequences exist. Significant nutritional deficiency may be seen in the obese both before and after their procedures. These nutritional abnormalities may be difficult to detect, with symptoms ranging in severity from mild to life threatening. Caring for patients who undergo weight-loss surgery presents a challenge for healthcare professionals. Noncompliance with follow-up care and supplementation may contribute to the undesirable consequences of surgery. A team of physicians, nutritionists, and psychologists who monitor blood values, reinforce the importance of regular supplementation, and address the psychological needs of these patients can help improve and possibly prevent significant side effects from bariatric surgery.46,73


Patients undergoing bariatric surgery experience rapid, massive weight loss that usually levels off around 15 to 18 months post-surgery. Typically, the individual is left as a thin waif in an oversized suit of skin. The resulting problems are both functional and aesthetic. It is the role of the plastic surgeon to tailor the patient’s skin, restore body image, and hide the seams.

It is of interest that a single bariatric operation can result in several plastic surgery procedures. More postoperative bariatric patients are demanding (and requiring) these procedures as awareness grows and as plastic surgeons apply improved surgical techniques. In 2004 alone, more than 106,000 body-contouring procedures were performed, with massive weight-loss patients accounting for nearly 56,000 procedures. Body-contouring procedures include breast (76,000), buttock (3,500), lower body (9,000), thigh (8,000), and upper arm lifts (10,000).

Functional problems following massive weight loss include intertrigo, chafing, interference with personal hygiene, and difficulty with sexual intercourse. Aesthetic issues revolve around loose folds of skin, which can be located on the abdomen, breasts, arms, legs, or face. Paradoxically, individuals who have lost a great deal of weight may lose some of the insurance-mandated minimum weight requirements for a breast reduction and have to pay out-of-pocket for what now will be considered a cosmetic procedure. In contrast, when a morbidly obese patient presents for a breast reduction, the plastic surgeon should consider referring the individual for a bariatric consultation because massive weight loss following breast reduction can...
result in an unacceptable loss of breast tissue (Figure 1).

The deformities resulting from massive weight loss are described here. However, it should be noted that not all patients have all deformities, and few deformities are identical among patients. The normal variability in physique and genetic make-up ensures a wide spectrum of diseases, differing priorities in management, and unique surgical approaches for various manifestations of the same abnormality. Broadly, there are 2 scenarios of massive weight loss following bariatric surgery. A significant number of patients have lost, for example, 150 lb, achieving a near-normal weight and have developed the appearance of a Shar-Pei dog, where skin redundancy is the major issue. Others have also lost 150 lb, but this has only taken them from 500 lb to 350 lb. In these individuals, the looseness of their skin is accompanied by a persisting soft bulkiness of the subcutaneous tissues with the texture of marshmallow. Generally speaking, much better results are achieved in body-contouring dermolipectomies when skin redundancy is not accompanied by bulky subcutaneous fat. Preliminary liposuction to specific areas can convert the bulky marshmallow to the Shar-Pei and thus improve the results of excisional postbariatric plastic surgery. Excessive subcutaneous fat severely limits the amount of tightening possible by conventional nip-tuck procedures. As with most aesthetic surgery, the patient make-up for body contouring following bariatric surgery is 10:1 female to male.

Whatever the pattern, the initial consultation usually involves complaints about an abdominal pannus, in addition to other integumentary disorders. In the past, panniculectomies have been performed with umbilical resection. Nowadays, the patient is more likely to receive an abdominoplasty with a low abdominal scar (Figures 2 and 3), a lower body lift (Figure 4), or a belt lipectomy—all with umbilical preservation. Where an umbilical hernia necessitates its removal, umbilical reconstruction is not out of the question.

After the abdomen, the other other areas female patients most frequently complain about are the breasts and arms (these areas make up the main complaints from men, also). Breast deformities often involve severe ptosis, skin excess, inferior migration of inframammary fold, loss of volume, and lateral chest folds (Figures 1, 2, and 5). However, hypertrophy may persist, necessitating a reduction in addition to a lift. Occasionally, an augmentation is indicated (Figure 5).

Batwing deformities of the arms can be severely embarrassing to patients and many refuse to wear short sleeves. The price of a brachioplasty is a visible scar, albeit on the inner aspect of the upper arm (Figure 5).

Many massive weight-loss patients have thin legs and do not need surgery for either functional or aesthetic reasons (Figure 4). More commonly, they have an excess of loose skin and “cellulite” presenting a moderate to severe aesthetic deformity (Figure 6). The soft tissues often have the marshmallow bulkiness described above. Some patients have massive skin redundancy with edema and stasis amounting to localized lymphedema (Figure 7). This can interfere with locomotion as well as personal hygiene.

Less common problems requiring surgery involve severe skin ptosis and wrinkling of the face and neck. The patient will complain of many of the sequelae of aging that are ordinarily treated by a cosmetic facelift. Other patients have redundant skin in the form of “back rolls.” These have been tackled by the so-called “upper body lift,” often in combination with a belt lipectomy or “lower body lift.”

When a patient requires multiple procedures, an effort is often made to combine some of them in order to achieve better overall results.
to shorten the time sequence and to minimize the complications from repeated general anesthetics and surgical interventions. The main danger is the risk of excessive blood loss because wide areas of dissection are the norm, and bariatric patients—owing to iatrogenic nutritional deficiencies—typically have suboptimal hemoglobin levels.10 Most surgeons would avoid combining a lower body lift with other surgeries, but any of the other procedures may be paired, provided a team approach is employed, autologous blood is available, and the patient’s general health is excellent.11

Abdomen

The rapid weight-loss patient typically presents with a massive abdominal pannus that hangs over the pubis and provides a warm, moist environment for fungal intertriginous infection (Figures 2-4). Active infections should be treated prior to surgery. An abdominoplasty removes the excess skin in the form of a transverse ellipse centered in the midline with its inferior border in the suprapubic region and its superior border passing above the umbilicus. Minimal undermining of the superior flap allows it to be drawn inferiorly for a bikini-line closure (Figures 2 and 3). The umbilicus is mobilized on its stalk and transposed to an anatomically correct position through the same superior flap.

The operation, although effective in treating intertrigo, has some severe limitations as well as special considerations in the massive weight-loss patient. Maximum tension is produced centrally where the greatest benefit is seen, but at the apices of the transverse ellipse there is, by definition, no increased tension. The result is a lateral laxity and often “dog-ears.”

In the lower body lift5 the excision is continued around the body with the posterior component skirting the upper borders of the buttocks before plunging as a dart into the natal cleft. Strong sutures maintain high lateral tension in the “superficial fascial system.”5 This has many benefits: producing a lift with even tension and no dog-ears, an aesthetic improvement in the buttocks, and a dramatic tightening in the lateral thighs (Figure 4). The surgery is much more extensive than a simple abdominoplasty and involves repositioning the patient during the surgery.

A “belt lipectomy” is a variation of this operation.6,7 Here the incision is placed somewhat higher and has some special advantages over a lower body lift: it helps define the waist and it removes more of the back rolls. However, it has a less beneficial effect on

**Figure 2.**

This patient underwent simultaneous abdominoplasty and breast lift 18 months after laparoscopic gastric bypass. If a lower body lift had been necessary, the author would not have combined the procedures.
the buttocks and thighs. Conversely, the lower body lift dramatically improves the buttocks and lateral thighs, but is less effective in defining the waist and eliminating back rolls.

Selection of operation is based on each patient’s particular deformity and his or her individual goals.

A special consideration in the rapid weight-loss patient undergoing abdominoplasty is the mons pubis. This structure is often severely redundant. It is frequently hidden by the abdominal pannus when the patient is standing, and, in the recumbent position, it may be even less obvious because of the familiar lipodissipation of gravity. Yet if not surgically corrected, the patient will be left with a highly embarrassing stigma of his or her presenting disease. The mons may be reduced in size by wedge excision, liposuction, direct fat excision, or subtotal (superior) amputation (Figure 3).7, 12

Breasts

In both men and women, massive weight loss can produce a severe aesthetic deformity of the breasts. The classical pentalogy consists of volume loss, skin excess, ptosis, low inframammary fold, and lateral rolls (Figures 2, 3, and 5). Any combination of these is possible, but occasionally no deformity is present at all.

Typically, the excess skin and volume loss make the breasts look empty; however, with an appropriate breast lift (mastopexy), the redundant skin is resected and the tissues formed into a compact and adequate shape (Figure 2). In other cases, an excess of breast tissue persists, necessitating a breast reduction. Postoperatively, the results are similar.

Some patients lose so much weight, however, that they are left with little or no breast tissue and may actually request some form of augmentation in addition to a lift (Figure 5). Here, there are pitfalls for the unwary plastic surgeon. As mentioned previously, massive weight-loss patients frequently have “incontinent” submammary folds. This is because the fibers of the superficial fascial system, which, by their deep attachments, form the inframammary folds, are stretched during morbid obesity and remain so after the individual loses weight. Unless some effort is made to reconstitute the inframammary folds, breast implants will simply slide down the chest wall producing the so-called “pseudo-ptosis” of the breast.

An interesting solution to the loss of breast tissue is “auto-augmentation,” whereby the extra tissue in the lateral roll is rotated into the breast as an inferomedially based flap.13 This may be performed during breast lift and upper body lift, killing 2 or 3 birds with 1 stone.

If not used in this way, the lateral rolls may be excised in lateral extensions of the mastopexy incisions. When these excisions pass circumferentially around the chest (hopefully in the bra line) an “upper body lift” is produced.9 This is helpful in removing the back rolls, which are frequently present in massive weight-loss patients.

Figure 3.
A 40-year-old male who had massive weight loss following gastric bypass. An abdominoplasty involved umbilical preservation and amputation of the upper two thirds of his mons pubis.
Figure 4.
This patient lost 100 lb following a gastric bypass procedure. She underwent a lower body lift using a circumferential excision. Every effort was made to conceal the resulting scar in the diminutive thong she provided. Note the tightening of the buttocks and the anterior thighs in addition to the abdomen.

Figure 5.
Brachioplasty, breast augmentation, and breast lift with fixation of the inframammary fold to the ribs.
In the male breast, a variety of problems are seen. If the redundancy of skin is not too bad, moderate gynecomastia may be removed by liposuction alone. However, more commonly skin needs to be removed; and this may be achieved by a periareolar excision combined with liposuction in mild cases. In severe cases, the breast is simply amputated in an oblique ellipse, placing a scar along the lower border of the pectoralis major muscle. The scar occupies the position of the pectoral crease and is surprisingly inconspicuous. The nipple is taken as a full-thickness skin graft, reduced in size, and applied to a de-epithelialized circle in the appropriate anatomical position of the upper “mastectomy” flap.

Arms

Batwing deformity is one of the most common complaints of the massive weight-loss patient. It consists of a large fold of skin hanging from each upper arm, typically extending from the posterior axillary fold to the medial epicondyle (Figure 5). In the most severe cases, the fold extends along the ulnar aspect of the forearm and down the lateral chest. The patient complains of being self-conscious wearing sleeveless or short-sleeved garments, and of difficulty getting clothes to fit.

A brachioplasty is basically an elliptical excision of the redundant fold, with the resulting scar placed on the inside of the arm. If necessary, it may extend onto the forearm or cross the axilla onto the lateral chest. In the latter case, a Z-plasty is often incorporated into the axillary portion of the closure to avoid webbing of the scar. Many surgeons omit this maneuver, substituting a lazy-S excision because webbing is uncommon and is
easy to treat later, should it occur.14,15

In the super-heavyweight weight-loss group, a certain degree of circumferential bulkiness may persist in addition to skin redundancy. The use of liposuction to supplement the brachioplasty will permit a more effective skin excision and produce a better result.

Thighs

Those patients who are spared the massive weight-loss deformity of the thighs (Figure 4) are fortunate because not only are the legs the most difficult area to treat, but also the postoperative recovery is the most uncomfortable and protracted.

At consultation, patients frequently grab the tissues of the thighs and hoist them up to smooth out the wrinkles while posing the inevitable question: “Why can’t you do this?”

It should be said at the outset that transverse (horizontal) “thigh lifts” do not work on the massive weight-loss patient. The pull from any skin resection will be in 2 directions at right angles to the line of closure; and the unfortunate product of a transverse skin excision in the groin crease is to drag the labia majora down the leg (euphemistically known as “scar migration”). Anchoring the Colles’ fascia to the deep fascia or even to bone is unhelpful because the Colles’ fascia itself has little strength remaining following the stretching of morbid obesity.

A well-executed lower body lift, as mentioned previously, will have an excellent effect on the anterior and lateral thigh skin (Figure 4).5 However, the medial thigh skin will be largely unaffected. A vertical elliptical skin excision down the medial aspect of the thigh is the most likely procedure to be effective. Once again, the patient with Shar-Pei skin can expect reasonable circumferential tightening, whereas the one with persisting marshmallow bulkiness (Figure 6) should initially be converted to Shar-Pei skin by liposuction. Medial thigh reductions have minimal benefit if the subcutaneous tissues remain bulky. Direct undermining of the skin flaps in thigh reduction is not recommended because of the risks of delayed healing and skin necrosis. Radical liposuction of the tissues to be excised may minimize blood loss. Occasionally, anterolateral excisions are used when the distribution of fat is atypical (Figure 6).

Other Areas/Looking Ahead

Plastic surgery in the massive weight-loss patient is an evolving science. Although the vast majority of procedures carried out consist of those listed here, there are other procedures that are performed occasionally and that may become more popular in the future.

Atrophy of the buttocks is frequently seen in the massive weight-loss patient. “Autoaugmentation” of the breasts has already been described, and a similar technique may be employed to augment the buttocks. The principle is to utilize the skin and subcutaneous tissues posteriorly between the upper and lower incisions of the lower body lift. This tissue may be de-epithelialized, shaped, rotated downward, and buried under the inferior skin flap.16 Rotation is severely limited, however, and the final position of the autoaugmentation is not always ideal.

An extension of the brachioplasty may be made down the side of the body from the posterior axillary fold to the iliac crest, rather like the seam of a jacket.15 Excision of a vertical strip of skin on each side produces horizontal abdominal tightening and indirectly eliminates the back folds with a scar that is more acceptable than the one that results from direct excision. To safeguard abdominal skin vascularity, this “lateral lift” should not be performed simultaneously with an abdominoplasty, belt lipectomy, or lower body lift.

Finally, many massive weight-loss patients develop redundant skin in the face and neck and require facelifts, brow lifts, and other facial aesthetic procedures for cosmetic reasons. The description of these procedures is beyond the scope of this review.

Conclusion

Patients who experience massive, rapid weight-loss often present with various problems and priorities. There is much individual variation not only in the presentations, but also in the surgical approaches to dealing with them. For the complete correction of the deformities associated with massive weight loss, multiple operations are usually required, and the resulting scars—although usually preferable to the problems of extreme skin laxity—can be extensive. Traditional reconstructive and aesthetic procedures may be adapted to the particular conditions associated with massive weight loss. Other techniques have been specifically devised for some of the unique problems encountered. Circumferential lower body lifts or belt lipectomies are usually performed alone. Other procedures may be safely grouped together. There is a spectrum of degree with subcutaneous fat loss, one extreme giving a Shar-Pei dog appearance, and the other producing tissues with the consistency of bulky marshmallows. Generally, better results are achieved with the former condition than the latter one. Liposuction may be used to convert the second condition to the first one and may facilitate definitive surgery.

References


*Dr. Boyd has no relevant financial information to disclose.*
Obesity is increasing in prevalence in our society and is associated with a variety of comorbidities, including diabetes and hypertension, that are best treated with weight loss. The only method for weight reduction shown to have effective long-term success is surgery. In 2003, more than 100,000 bariatric procedures were performed, and this number is expected to increase as the population continues to gain weight.

The field of bariatric surgery is evolving because an ideal procedure has not yet been identified. All procedures performed for morbid obesity have significant associated risks, including a mortality of 0.5% in one recent meta-analysis for Roux-en-Y gastric bypass procedures. This imperfection of existing treatments and the increasing prevalence of the disease has led several groups to work on improving techniques. Many of the advances on the horizon in bariatric medicine focus on natural orifice therapies, and these procedures are the focus of this review.

**Natural Orifice Procedures**

Natural orifice procedures are approaches that can be performed entirely through natural openings, without resulting in external scars. They can either be performed within a lumen via the endolumenal approach, which was first developed in the early 1980s, or across a lumen via natural orifice transluminal endoscopic surgery (NOTES), a promising new approach initiated in Asia. Several types of bariatric procedures can be performed through these routes. Short-term devices may be placed for weight loss in preparation for a definitive procedure to reduce operative mortality or morbidity, or for cosmetic purposes for a specific event (eg, a wedding). Revisional bariatric procedures may also be performed using a natural orifice approach to reduce a stoma size, repair a fistula, or...
possibly to create a new anastomosis. Performing revision via the endolumenal approach can minimize some of the difficulty in standard revisional surgery by avoiding adhesions in the new operative plane. In addition to these applications, natural orifice procedures can be used for new primary bariatric surgical procedures to provide durable weight loss.

Initial Endolumenal Devices

**Garren-Edwards Bubble**

One of the first endolumenal devices used for morbid obesity was the Garren-Edwards Bubble. This cylindrically shaped space-occupying device was placed endoscopically into the gastric lumen. The initial concept was proposed in 1982, and the device received FDA approval in 1985. It was exceedingly popular despite minimal proven results, and 25,000 devices were placed before it was removed from the market. Several sham-controlled trials showed no benefit from the device, and it was associated with several significant complications, including ulcer or erosion in 40% of patients, Mallory-Weiss tears in 11%, and small bowel obstruction in 2%.5,6

**BioEnterics Intragastric Balloon**

BioEnterics Corporation worked to develop an improved version of the Garren-Edwards Bubble and released the BioEnterics Intragastric Balloon (BIB) system in the mid-1990s (Figure 1).7 The device is available internationally but is not FDA approved for use in the United States. There are several studies showing good short- to midterm results with the device, but only 1 published study is sham controlled. The sham-controlled study randomized patients to receive the balloon or no balloon (sham) for 3 months, followed by additional 9 months with a balloon exchanged every 3 months (Figure 2). Patients were then followed for 12 months after balloon removal. Both groups lost weight (30% of excess weight, with some sustained weight loss at 1 year after removal), but there was no significant difference between the groups. Patients in both groups experienced frequent symptoms with the balloon in place, including nausea, vomiting, and pyrosis on more than 50% of days. All of these complaints were more prevalent in patients who had the sham procedure before balloon placement. The BIB was found to be safe (it can be kept in place for up to 6 months without significant morbidity8), but patients had frequent complaints, and the benefit of balloon over sham was not proven. Despite these results, the BIB is still popular in Europe and may be of benefit in facilitating compliance with behavioral portions of a weight-loss program.

Modifying Current Devices For Endolumenal Bariatric Surgery

There are a few devices on the market in the United States today that may be modified for bariatric surgical

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**Figure 1. BioEnterics Intragastric Balloon.**
Reprinted from reference 7.

**Figure 2. Weight loss with Bioenterics Intragastric Balloon.**
Group 1: sham for first 3 months, Group 2: balloon for first 3 months. Both groups had balloons in place months 3-12, and no balloon months 12-24.

BMI, body mass index
Reprinted from reference 8.
procedures. There has been some success with the Endocinch (CR Bard Inc.) for treatment of gastrogastric fistulae and management of anastomotic dilatation.9 Others have also reported success using this device for endoscopic management of gastrojejunal anastomotic dilation.10,11 The NDO plicator (NDO Surgical Inc.) may also have bariatric applications. Power Medical (Power Medical Interventions Inc.) recently released a transoral stapling device that can provide endolumenal stapling. Such endolumenal devices may also facilitate transoral procedures involving gastric restriction. Other companies are developing similar devices, some of which are detailed below.

**VERTICAL BANDED GASTROPLASTY**

An endoscopic sewing machine (Endoscopic Sewing Machine; CR Bard Inc.) mounted at the tip of a flexible gastroscope has been used to create an endoscopic vertical banded gastroplasty. This procedure uses a 3-cm plastic ring sutured to the lesser curvature of the stomach 8 cm from the gastro-esophageal junction. An 8-cm-long tube is created along the lesser curvature by suturing the anterior and posterior walls of the stomach with the endoscopic sewing machine. Survival studies have not shown this to be durable or effective.12 The Endoscopic Suturing Device by Wilson-Cook Medical could be similarly applied.

**Techniques in Development**

Most of the new techniques being developed focus on 2 key principles: endoscopic restriction or transgastric surgery. The companies working on restriction focus on gastric plication, internal stapling, and restrictive valves. Other companies are evaluating intraluminal approaches to malabsorption. None of these devices or techniques has been proven safe and effective.

**GASTRIC POUCH FROM WITHIN GASTRIC LUMEN**

The Eagle Claw prototype endoscopic suturing device (Olympus Corporation) has been used in a porcine model to create a gastric pouch entirely from within the gastric lumen (Figures 3 and 4).13 There are no published studies evaluating survival using this approach.

**ENDOLUMENAL PLACEMENT OF INTRAGASTRIC MESH**

Endolumenal placement of intragastric mesh has also been attempted in a study in dogs. In this procedure, mesh is passed transorally and secured with laparoscopic intragastic suturing. The final outcome is a 30- to 50-mL gastric reservoir emptying through a 1.5-cm central aperture. Of the 10 dogs in the study, 2 had 100% adherence of the mesh and 4 had some adherence. Four dogs had no mesh adherence, suggesting that this approach is not conducive to broader therapeutic applications without novel ways to increase mesh adherence.14

*Figure 3. Eagle Claw endoscopic suturing device.*

*Figure 4. Gastric restriction with the Eagle Claw.*
Endoscopic Truncal Vagotomy

Endoscopic truncal vagotomy has also been suggested as a less invasive approach to morbid obesity. This is based on the concept that patients with peptic ulcer disease lose weight after gastrectomy and truncal vagotomy. Ghrelin is reduced after gastrectomy, and truncal vagotomy abolishes its appetite-stimulating effects. Although no work has been published in this area, development of an endoscopic gastroplasty with truncal vagotomy is an appropriate target for future research.

Other New Devices and Approaches

There are a variety of other technology companies developing new bariatric procedures and devices. BaroSense is developing techniques for transoral procedures for gastric restriction with or without combined malabsorptive devices for surgical weight loss. BaroNova Therapeutics Inc. has a gastric-retention technologies group that has created a polymer pill that expands to take up space in the stomach for 1 week after ingestion or delivery. In theory, this pill would degrade and pass through the gastrointestinal system and could be taken at regular intervals and titrated based on response. Although no clinical trials have been published with either of these devices, the technology appears promising. Satiety has developed the TOGa System transoral gastroplasty. A safety trial in 12 patients was successfully completed. At 3 months, patients had lost an average of 24.7 pounds and 20.5% of their excess body weight. Initial results with this technique were presented at the annual meeting of the Society of American Gastrointestinal and Endoscopic Surgeons in April 2007.

An endolumenal bariatric sleeve has been developed by GI Dynamics. This device is a flexible, endoscopically placed sleeve open at both ends and positioned in the duodenum up to the ligament of Treitz. The sleeve allows food to pass, while preventing duodenal mixing of chyme with biliary and pancreatic secretions to mimic the duodenal and proximal jejunal bypass impact of a Roux-en-Y gastric bypass. The device is anchored past the duodenal bulb, and can be endoscopically removed, allowing reversibility. In addition to facilitating weight loss, this device may also have value in the management of type 2 diabetes. Animal studies of the device are ongoing.

Natural Orifice Transluminal Endoscopic Surgery

Transgastric or transcolonic access for surgical procedures through natural orifices is also a promising new approach (Figure 5). There is significant controversy about NOTES because surgical access across the wall of the gut introduces new variables to surgery. These variables include contamination from luminal organisms, injury of other organs during access, and the need for secure closure of the access organ on exit.

A group of US surgeons and gastroenterologists have combined efforts to create the Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR) to study the NOTES approach (www.noscar.org). This group has published a white paper and held a conference on NOTES. A second conference is planned for July in Boston.

Rao and Reddy at the Asian Institute of Gastroenterology in Hyderabad, India, have performed this technique on patients in general surgery procedures. They have presented their approach at many meetings but have yet to subject their work to peer review of the outcomes and have not published in a widely circulated journal.

Of the few studies that have been published on the NOTES techniques, most used a porcine model. Park et al from Sweden described techniques for using the NOTES approach for biliary surgery, including cholecystectomy and cholecystogastric anastomosis. Their 2005 publication was accompanied by videos detailing transgastric access techniques with standard endoscopic tools. Kelloo and the Apollo Group have published multiple papers on NOTES techniques and novel devices developed in conjunction with Olympus. Thompson has championed a transcolonic approach to improve orientation for upper abdominal procedures. Swanstrom and colleagues have published work on devices to facilitate NOTES. Onders and colleagues have suggested some applications of NOTES in the intensive care unit environment and have proven feasibility in a porcine model. There are many biotechnology companies doing work in this area, and new publications are coming out monthly. During the next few years, this field will likely grow dramatically, and innovative forays into bariatric surgery are expected to be on the forefront of those advances.

Conclusion

Sorting through the possibilities for the future of bariatric surgery may seem daunting as many new techniques and devices for weight-loss surgery are
being developed. The majority of these developments still focus on the proven surgical concepts of restriction and malabsorption but with a less invasive approach. Fueling development for these advances are the tremendous need in contemporary society for safe, effective, and lower-cost outpatient treatments for the millions of people suffering from obesity and the poor track record of nonsurgical treatments for this complex, multifactorial disease.

Above all, the ideal device for less invasive weight-loss surgery needs to be safe. As evidenced by intragastric usage data, patients are willing to undergo these procedures without clinical evidence of success. Candidates for bariatric surgery are eager for any promise of weight-loss benefit and therefore are exceedingly vulnerable to promises of benefit despite a lack of strong evidence for a procedure’s success and safety. It is paramount that patient safety be protected. Additionally, any new technology that is adopted and implemented should be easy to deploy and should offer an efficacy benefit compared with existing procedures. These “future treatment options” are on the horizon.

References

Dr. Pryor has been a consultant for Barosense, Synecor, TransEnterxy, and Valleylab, is a stock shareholder of Barosense and TransEnterxy, and has received honoraria from and has been on the speaker’s bureau for Tyco Healthcare.

Dr. DeMaria has received grants/research support from Tyco Healthcare, has been a consultant for Power Medical Interventions, Inc., and has received honoraria from Tyco Healthcare, Stryker, and Ciné-Med.