Bariatric Surgery for Type 2 Diabetes Reversal: The Risks

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The twin epidemics of obesity and type 2 diabetes are on the rise. From 1986 to 2000, the prevalence of BMI 30 kg/m^2 doubled, whereas that of BMI >40 kg/m^2 quadrupled, and even extreme obesity of BMI 50 kg/m^2 increased fivefold (1). Of particular concern is the alarming increasing prevalence of obesity among children, suggesting that the epidemic will worsen (2). The impact of obesity on longevity has been well documented. In the world, over 2.5 million deaths annually can be attributed to obesity; in the U.S. alone over 400,000 deaths attributable to obesity occur per year—second only to those attributable to cigarette smoking. There is a direct relationship between increasing BMI and relative risk of dying prematurely, as evidenced in the Nurses' Health Study with a 100% increase in relative risk as BMI increased from 19 to 32 kg/m^2. Annual risk of death can be as high as 40-fold that of an age- and sex-matched nonobese cohort (3,4). The Framingham data revealed that for each pound gained between ages 30 and 42 years there was a 1% increased mortality within 26 years, and for each pound gained thereafter there was a 2% increased mortality. Only one in seven obese individuals will reach the U.S. life expectancy of 76.9 years. In the morbidly obese population, average life expectancy is reduced by 9 years in women and by 12 years in men.

It has been over 10 years since the resolution of type 2 diabetes was observed as an additional outcome of surgical treatment of morbid obesity. Moreover, it has been shown unequivocally that diabetes-related morbidity and mortality have declined significantly postoperatively, and this improvement in diabetes control is long lasting. Bypass procedures, the Roux-en-Y gastric bypass (RYGBP) and the biliopancreatic diversion (BPD), are more effective treatments for diabetes than other procedures and are followed by normalization of concentrations of plasma glucose, insulin, and HbA_{1c} in 80–100% of morbidly obese patients. Studies have shown that return to euglycemia and normal insulin levels occurs within days after surgery, long before any significant weight loss takes place. This fact suggests that weight loss alone is not a sufficient explanation for this improvement. Other possible mechanisms effective in this phenomenon are decreased food intake, partial malabsorption of nutrients, and anatomical alteration of the gastrointestinal (GI) tract, which incites changes in the incretin system, affecting, in turn, glucose balance. Better understanding of those mechanisms may bring about a discovery of new treatment modalities for diabetes and obesity.

Lifestyle intervention programs with diet therapy, behavior modification, exercise programs, and pharmacotherapy are widely used in various combinations to treat obesity. Unfortunately, with extremely rare exceptions, clinically significant weight loss is generally very modest and transient, particularly in patients with severe obesity (5,6). The failure rate for those programs is around 95% at 1 year.

There is a great interest in the mortality and morbidity associated with bariatric surgery in the medical community, in the media and, understandably, in the minds of morbidly obese patients. In part, this interest is due to the universal appreciation of the consequences of the global obesity epidemic, the growing recognition that bariatric surgery is currently the most effective therapy for the disease of morbid obesity, and that the increasing numbers of bariatric procedures have reached over 200,000 annually in the U.S. and half a million annually worldwide (5). Yet, because there is still reluctance to accept obesity, and even morbid obesity, as a disease entity, the surgery for this problem and its operative mortality are not well accepted by the medical and lay communities.

Per the 1991 National Institutes of Health Consensus Conference Guidelines, patients are considered as surgical candidates only if their BMI is ≥40 kg/m^2, or if their BMI is >35 kg/m^2 and they suffer from other life-threatening comorbidities such as type 2 diabetes, hypertension, and cardiovascular disease.

TYPES OF BARIATRIC PROCEDURES—Bariatric surgery armamentarium includes several surgical options. Vertical banded gastroplasty (VBG) was developed by Mason et al. (7). In VBG, the stomach is partitioned with staples and fitted with a plastic band to restrict the passage of food through the stomach. In contrast to GI bypass surgeries, VBG does not involve rerouting of food within the digestive tract. Though popular in the 1980s, the procedure has been progressively abandoned.

Laparoscopic adjustable gastric banding

The original, open gastric banding procedure developed in the early 1990s was modified to become a laparoscopically implanted device by the mid-1990s. Laparoscopic adjustable gastric banding (LAGB) (Fig. 1) is a restrictive procedure that involves encircling the upper part of the stomach with a band-like, fluid-filled tube (8). The band is wrapped around the superior portion of the stomach, just distal to the gastroesophageal junction. The amount of restriction can be adjusted by injecting or

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This publication is based on the presentations at the 3rd World Congress on Controversies to Consensus in Diabetes, Obesity and Hypertension (CODHy). The Congress and the publication of this supplement were made possible in part by unrestricted educational grants from AstraZeneca, Boehringer Ingelheim, Bristol-Myers Squibb, Daiichi Sankyo, Eli Lilly, Ethicon Endo-Surgery, Generex Biotechnology, F. Hoffmann-La Roche, Janssen-Cilag, Johnson & Johnson, Novo Nordisk, Medtronic, and Pfizer.
DOI: 10.2337/dc11-s254

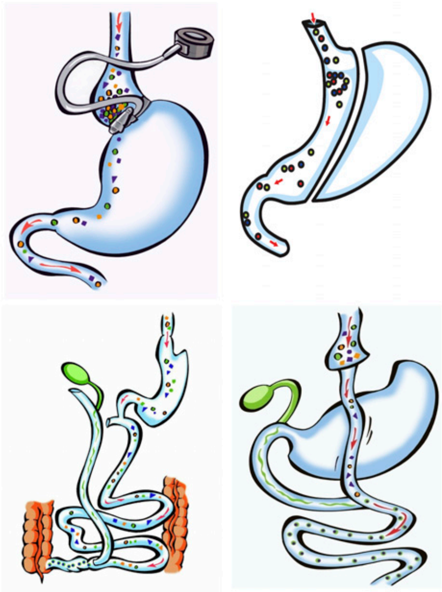

Figure 1—*Four common bariatric procedures. Adjustable gastric banding* (upper left panel)*: In this procedure an adjustable silicon ring constricting the cardia of the stomach is placed and imbricated to prevent slippage of stomach in a retrograde manner through the band. These bands are generally placed by LAGB. SG* (upper right panel)*: This is a restrictive procedure that creates a 100- to 150-mL stomach by performing a partial gastrectomy of the greater curvature side of the stomach. The last 6–8 cm of antrum remains intact, and thus, the pylorus is preserved to help prevent gastric emptying problems. RYGBP* (lower right panel)*: Gastric bypass partitioned. In this version of gastric bypass, the stomach is partitioned rather than divided. A Roux-en-Y gastrojejunostomy is done with variable lengths. The alimentary limb refers to the jejunal Roux-en-Y limb anastomosed to the stomach. The biliopancreatic limb transmits bile and pancreatic secretions to the jejunojejunostomy where the ingested nutrients and digestive juices first mix. The common channel refers to the distance from the enteroenterostomy to the ileocecal valve. BPD-DS* (lower left panel)*: In this original description, an approximate 50–80% gastrectomy is done. Limb lengths vary from a gastric bypass in that the enteroenterostomy is very distal, creating a common channel 50–100 cm in length. The forward flow of bile and pancreatic juice in the biliopancreatic limb is believed to reduce complications of bacterial statis that were associated with the long blind loop of intestinal bypass.*

withdrawing saline solution from the hollow core of the band through a subcutaneous port similar to that used for long-term venous access in chemotherapy patients.

RYGBP

After its first report by Mason and Ito (9) in 1967, the technique of gastric bypass has undergone several modifications. The most current technique, RYGBP, involves the use of a surgical stapler to create a small and vertically oriented gastric pouch (Fig. 1). This pouch is located on the lesser gastric curvature, and its volume is usually <30 cc. The upper pouch is completely divided from the gastric remnant and is anastomosed to the jejunum (30–70 cm from the ligament of Treitz) through a narrow gastrojejunal anastomosis in a Roux-en-Y fashion. Bowel continuity is restored by an entero-entero anastomosis between the excluded biliopancreatic limb and the alimentary limb. This anastomosis is usually performed 100–150 cm distal to the gastrojejunostomy, although it has also been performed at 100–250 cm in patients with BMI >50 kg/m^2. After RYGBP, ingested food bypasses most of the stomach and the first part of the small intestine.

BPD

The concept of BPD was first described by Scopinaro et al. (10) in 1979. The operation consists of a distal, horizontal gastrectomy that leaves behind a functional upper stomach 200–500 ml in size (according to the individual patient's characteristics).This remnant stomach is anastomosed to the distal 250 cm of small intestine (alimentary limb). The excluded small intestine (including the duodenum, the jejunum, and part of the proximal ileum) carries bile and pancreatic secretions (biliopancreatic limb), and it is connected to the alimentary channel 50 cm proximal to the ileocecal valve. The 50-cm "common limb" is the only segment of small bowel where digestive secretions and nutrients mix. Fat and starches are absorbed in this short common limb, whereas the alimentary limb (usually 200–250 cm in length) allows absorption of some proteins and simple carbohydrates.

BPD with duodenal switch

The BPD with duodenal switch (BPD-DS) includes a "sleeve" vertical gastrectomy (rather than a horizontal version, as in Scopinaro's original procedure), which leaves a 150- to 200-ml gastric reservoir (Fig. 1). The duodenum is closed 2 cm distal to the pylorus, and a duodeno-ileal anastomosis is performed (DS). Hence, the gastric fundus is almost entirely resected, and the antrum, pylorus, and a very short segment of duodenum are preserved, along with the vagus nerve. Bowel continuity is restored as in BPD; however, the entero-entero anastomosis is performed more proximally on the alimentary limb, leaving a longer common channel of 100 cm, as opposed to 50 cm in the original procedure of Scopinaro et al. The BPD-DS operation was conceived by Hess et al. (11), but first reported by Marceau et al. (12) in 1998.

Sleeve gastrectomy

To shorten the duration of the laparoscopic BPD-DS in high-risk patients, Gagner et al. (13) proposed a two-stage approach in which sleeve gastrectomy (SG) is performed first (Fig. 1), with the duodenoileostomy and ileoileostomy as a second stage a few months later. This approach resulted in reduced surgical morbidity and mortality compared with the traditional one-stage approach in supersuper-obese patients (BMI >60 kg/m^2). Unexpectedly, patients achieved remarkable weight loss after the first stage of this approach, and SG is now being proposed as an independent antiobesity operation by some authors. The long-term efficacy of the procedure, however, needs to be further investigated.

DIABETES AND BARIATRIC SURGERY—Although diabetes is traditionally viewed as a chronic, relentless disease in which delay of end-organ complications is the major treatment goal, bariatric surgery offers a novel end point: major improvement or even complete disease remission.

EFFECT OF BARIATRIC SURGERY ON TYPE 2 DIABETIC SUBJECTS WITH BMI >35 KG/M^2: THE EVIDENCE—A systematic review and meta-analysis of the English literature reported complete resolution of type 2 diabetes (defined as discontinuation of all diabetes-related medications and blood glucose levels within the normal range) in 78.1% of cases. This percentage increased to 86.6% when counting patients reporting improvement of glycemic control, and diabetes resolution occurred in concomitance with an average weight loss of 38.5 kg (55.9% of the excess weight) [14]).

Two large case-series studies, by Pories et al. (15) (330 patients) and Schauer et al. (16), focused principally on diabetes outcomes after RYGBP. In the former study, mean fasting blood glucose (FBG) decreased from clearly diabetic values to near normal levels (117 mg%), and HbA_{1c} fell to normal levels (6.6%) without diabetes medicines in 89% of patients. In the latest study by Schauer et al., researchers provided the in-depth evaluation of the clinical outcome in 240 diabetic morbidly obese bariatric patients with a follow-up rate of 80%. The authors noted that after surgery, weight and BMI decreased from 308 lbs and 50.1 kg/m^2 to 211 lbs and 34 kg/m^2 for a mean weight loss of 97 lbs and mean excess weight loss of 60%. Fasting plasma glucose and HbA_{1c} concentrations returned to normal levels (in 83%) or markedly improved (in 17%) in all patients. A significant reduction in use of oral antidiabetic agents (80%) and insulin (79%) followed surgical treatment. Patients with the shortest duration (<5 years), the mildest form of type 2 diabetes (diet controlled), and the greatest weight loss after surgery were most likely to achieve complete resolution of type 2 diabetes.

Two prospective, controlled studies have addressed changes in glycemic control after bariatric surgery. The multicenter Swedish Obese Subjects (SOS) study compared bariatric surgery (LAGB, n = 156; VBG, n = 451; RYGBP, n = 34) with medical weight-loss treatment in well-matched obese patients (17). Bariatric surgery caused an average 16.1% weight loss at 10 years, compared with a small weight gain in control subjects. Mean weight loss was greater after RYGBP (−25.0 kg) than after LAGB (−13.2 kg) or VBG (−16.5 kg). Mean FBG tended to increase during the study in nonsurgical controls (+18.7% at 10 years), whereas a substantial decrease was seen in surgical patients at 2 years (−13.6%) and 10 years (−2.5%). The risk of developing diabetes was more than three times lower for surgically treated patients at 10 years, and recovery rates from diabetes were three times greater. Dixon et al. (18) reported a randomized controlled trial comparing LAGB to conventional type 2 diabetes management in subjects with BMI 30–40 kg/m^2 who had early (<2 years duration) and relatively mild diabetes. LAGB promoted significantly larger reductions in FBG, HbA_{1c}, and diabetes medication usage. The best diabetes improvement has been shown to occur in BPD. Scopinaro et al. (19) showed a stunning 97% euglycemia in 268 diabetic patients at 10 years after surgery.

The antidiabetic effect of bariatric surgery is long lasting. Long-term control of glycemia and normal levels of HbA_{1c} after RYGBP have been documented in large series with up to 16 years of follow-up (16).

There is now enough evidence to state that bariatric surgery may reduce mortality in patients with diabetes. In the analysis by Adams et al. (20), deaths attributed to diabetes were reduced by 92%. Thus, there can be little doubt that in very obese patients with type 2 diabetes, bariatric surgery in general is a highly effective means of treating type 2 diabetes.

Consequently, conventional bariatric procedures are being used worldwide to treat type 2 diabetes in association with obesity, and increasingly among less obese or merely overweight patients.

BARIATRIC AND OTHER GI OPERATIONS IN TYPE 2 DIABETIC PATIENTS WITH BMI <35 KG/M^2—The remarkable control of diabetes in severely obese patients, along with experimental studies showing that GI operations can improve diabetes in both obese and nonobese animals (21–24), suggests that surgery may be beneficial for moderately obese or nonobese patients with type 2 diabetes.

Recent data on the existent clinical results of bariatric operations in type 2 diabetic patients with BMI <35 kg/m^2 were reviewed by Fried et al. (25). Most of the data were reported from countries outside of the U.S., and included were 343 patients who underwent one of eight procedures with 6- to 216-month follow-up. Most of the procedures were conventional bariatric operations, but there were also two experimental procedures—ileal interposition with SG or diverted SG. Patients lost a clinically meaningful but not excessive amount of weight (from BMI 29.4 to 24.2 kg/m^2; decrease of 5.1 kg/m^2), moving from the overweight into the normal weight category. Of the patients, 85.3% were off type 2 diabetes medications with fasting plasma glucose approaching normal (105.2 mg/dL; decrease of 93.3), and normal HbA_{1c}, (6%; decrease of 2.7). Operative mortality was at 0.29%. The improvement was better in the malabsorptive operations than the restrictive ones, and interestingly, the the higher BMI subgroup (obesity range: 30–35 kg/m^2) resolved their type 2 diabetes at a significantly higher rate than the lower BMI subgroup (overweight range: 25–29.9 kg/m^2).

Increasingly, experimental procedures are being used for treatment of type 2 diabetes in nonbariatric population in a study protocols. DePaula et al. (26) from Brazil reported on 454 patients who underwent a laparoscopic ileal interposition with SG with mean BMI of 29.7 ± 3.6 kg/m^2 (range 19–34.8) and duration of diabetes of >3 years; insulin therapy was used by 45.6% of patients; mean duration of type 2 diabetes was 10.8 ± 5.9 years (3–35); mean HbA_{1c} was 8.8 ± 1.9%; mean postoperative BMI was 25.8 ± 3.5 kg/m^2; mean fasting plasma glucose decreased from 198 ± 69 to 128 ± 67 mg/dL, and mean postprandial plasma glucose decreased from 262 ± 101 to 136 ± 43 mg/dL. Complication rate was no lower for this procedure than for the conventional bariatric procedures; mortality was 0.4%. There were 29 major complications (6.4%) in 22 patients (4.8%) and 51 minor complications (11.2%). Reoperations were performed on 8 patients (1.7%).

POSSIBLE MECHANISMS—Putative weight-independent antidiabetes mechanisms of GI surgery have been reviewed by Rubino et al. (21–24). Briefly, proposed hypotheses include the following: *1*) increased postprandial secretion of L cell peptides such as glucagon-like peptide 1 from enhanced distal-intestinal nutrient delivery (hindgut theory); *2*) exclusion of the proximal small intestine from nutrient flow, possibly down-regulating unidentified anti-incretin factor(s) (foregut theory); *3*) impaired ghrelin secretion; *4*) changes in intestinal nutrient-sensing mechanisms regulating insulin sensitivity; *5*) bile acid perturbations; and *6*) alterations in undiscovered gut factors, especially in the duodenum. Although the precise mechanisms mediating type 2 diabetes remission after certain GI procedures are not yet clear, it is apparent that rearrangements of GI-tract anatomy can exert several discrete antidiabetic effects beyond those related to reduced food intake and body weight. Various GI manipulations engage these mechanisms to differing degrees, and it is likely that operations with dramatic antidiabetes impact, such as RYGBP, activate several of them in complementary ways. Beyond the few hormones whose changes after GI surgery have been studied, the gut produces >100 known bioactive peptides and possibly other undiscovered relevant factors. Clarifying the molecules responsible for the benefits of GI surgery on glucose homeostasis is a compelling research objective that promises to inform the design of novel pharmaceutical therapies.

THE RISKS AND COMPLICATIONS OF BARIATRIC SURGERY

—Risks of bariatric surgery are easily quantifiable and can be divided into mortality and postoperative early and late complications.

The operative mortality of bariatric surgery depends on many diverse factors (28). These can be surgeon- and facility-related (e.g., the skill of the bariatric surgeon and the experience of team involved in the preoperative work up, detection and treatment of complications, which in general terms can be defined as a "learning curve," the available equipment of the institution in which the surgery is performed; the volume of procedures being performed; and the stage in the "learning curve" of the surgeon and the institution) or patient-related (e.g., operative selection: purely restrictive, malabsorptive, or combined; demographic characteristics with respect to age, sex, race, and weight, body habitus; and the presence of significant comorbidities such as diabetes, hyperlipidemia, hypertension, and obstructive sleep apnea). Indeed, operative selection algorithms have been attempted to match a specific patient with a specific operation in order to, among other factors, minimize operative mortality (29).

Cumulative reviews of the literature are biased. They enumerate the results of some of the worst mortality outcomes when emphasizing outcomes in patients in the higher age ranges and in the presence of severe comorbidities (30–32). Regional mortality data (33) may not reflect country-wide statistics as well because of the total absence of reports by some of the best bariatric surgeons with a low operative mortality—community surgeons with a large practice who do not report their outcomes. At the same time, surgeons and institutions—both community and academic—tend to publish only the good outcomes. This criticism is not limited to bariatric surgery and can be leveled at any cumulative review of any clinical procedure(s), especially operative procedures. It is impossible to extrapolate the effect of these missing data.

In the latest and most comprehensive meta-analysis available, Buchwald et al. (28) report on the <30-day and 30-day to 2-year mortality in 85,048 patients who underwent bariatric surgery from 478 treatment groups in 361 studies, published from 1 January 1990 to 30 April 2006. They focused on five areas of interest: mortality by procedure (laparoscopic gastric banding, open and laparoscopic gastroplasty, open and laparoscopic gastric bypass, open and laparoscopic BPD-DS, and revisions/reoperations); mortality by procedure type (restrictive, restrictive/malabsorptive, malabsorptive); mortality by publication year; mortality by study design; and mortality for subgroups, such as males versus females, the elderly, and the superobese. The main finding of this study was the relatively low mortality associated with bariatric surgery. Total mortality at <30 days was 0.28%; total mortality between 30 days and 2 years was 0.35%. This compares favorably to other common operative procedure mortality rates published: the population based in-hospital mortality after common operations in U.S. hospitals for aortic aneurysms (3.9%), coronary artery bypass grafting (3.5%), craniotomy (10.7%), hip replacement (0.3%), pancreatectomy (8.3%), and pediatric heart surgery (5.4%).

There have been several reports on the efforts to search for the preoperative predictors of patient-related mortality (34,35). Prospectively collected data from 4,431 consecutive patients undergoing a primary gastric bypass at four bariatric programs recruited to validate the proposed system were analyzed to assess means of stratifying surgical mortality risk. This Obesity Surgery Mortality Risk Score (OS-MRS) assigns one point to each of five preoperative variables, that were found to be significant predictors of mortality in many previous studies. These factors include BMI >50 kg/m^2, male sex, hypertension, known risk factors for pulmonary embolism (previous thromboembolism, preoperative vena cava filter, hypoventilation, pulmonary hypertension), and age >45 years. Patients with total score of 0 to 1 are classified as "A" (lowest) risk group, score 2 to 3 as "B" (intermediate) risk group, and score 4 to 5 as "C" (high) risk group. Mortality for 2,164 class A patients was 0.2%, for 2,142 class B patients was 1.1%, and for 125 class C patients was 2.4%. Mortality was significantly different between each of the class A, B, and C groupings ($P < 0.05$). Mortality was fivefold greater in the class B group than in class A, and 12-fold greater in Class C patients than the lowest risk group, A.

Are there are ways to predict, avoid, or decrease mortality? One of the ways to predict mortality is to use the abovementioned score. It should be noted that the best demonstrated and most protective effect against mortality is an experienced surgeon and hospital (36,37).

NONFATAL COMPLICATIONS

—The range of complications after weight-loss surgery depends on the specific procedure (8). Restrictive procedures (LAGB, VBG, SG) seldom affect bowel function and do not cause malabsorption, and consequently vitamin and other deficiencies are rare unless intractable vomiting is produced. Erosion of the band into the stomach causes abdominal pain and is associated with loss of efficacy. Aggressive filling of the band causes band slippage (8,38).

Unlike these simple restrictive procedures, operations that create malabsorption can cause a range of nutritional deficiencies.

Other complications are classified as early or late. Early complications (i.e., within the 1st month) were summarized in a collective review by Podnos et al. (39). Wound problems and incisional hernias are reported in an average of 2.98 and 0.47%, respectively, after laparoscopic bypass. Small-bowel obstruction (2.1%), anastomotic stenosis (0.7%), GI hemorrhage (0.6%), leaks (1.2%), pulmonary embolus (<1%), and pneumonia (0.1–0.3%) are all complications that can occur after a gastric bypass procedure. Many other late complications are a consequence of disordered GI tract function rather than failure of healing. Nutritional deficiencies include protein-calorie malnutrition, mineral deficit (calcium and iron), and vitamin deficiency. These can result from poor oral intake (through anorexia, inadequate supplementation, prolonged vomiting, or stricture formation) or failure of absorption (40).Weakness and lower-extremity edemas are signs of protein deficiency. A variety of neurological complications are reported, including Wernicke's encephalopathy and beriberi from thiamine deficiency due to repeated vomiting, peripheral neuropathy, and spinal cord lesions from vitamin B12 and folate deficiency (41).

All forms of gastric bypass and BPD with or without DS isolate the duodenum and proximal jejunum from ingested food and the reduction of absorptive area creates a risk of iron and calcium deficiency. Iron deficiency is especially a problem because the majority of patients are menstruating women, in whom iron deficiency is more significant (42,43). This is a greater problem after primarily malabsorptive procedures such as BPD-DS. The long-term effect of this calcium deficiency is reduced bone density, a potentially worrying problem for the future because the majority of patients are also at risk for osteoporosis in later life. Vitamin D deficiency may also be responsible for chronic weakness and pain of the proximal muscles, often mislabeled fibromyalgia. Gastroesophageal reflux disease symptoms of heartburn and regurgitation are rarely seen after RYGBP or laparoscopic banding but are not infrequent after BPD-DS or SG (8,44). Bowel disturbances are common after malabsorptive procedures. These include malodorous flatulence and diarrhea, especially if the common channel is short (50–75 cm). Some adaptation occurs with time. RYGBP and purely restrictive procedures are more commonly associated with constipation as a consequence of the reduced intake of fiber. Cholelithiasis and its consequences are known to develop after rapid weight loss for any reason (8).

RISK AND BENEFIT RATIO OF BARIATRIC SURGERY IN TYPE 2 DIABETES—Diabetes is strongly associated with increased morbidity and mortality following bariatric surgery. The impaired healing associated with diabetes may contribute to its role as a significant risk factor for leak (34). On the other hand, the benefits of bariatric operations in morbidly obese diabetic patients can hardly be exaggerated. Recent data show an up to 92% reduction in diabetes-related mortality after gastric bypass (20).

A "back of the envelope" calculation by Purnell et al. (45) highlights the issue. If the number of gastric bypass operations performed in patients with diabetes increased to 1 million per year (from the total number of procedures being performed in the U.S., which is now estimated at 225,000 per year) (8), the currently estimated 1-in-200 risk of perioperative death for all patients undergoing gastric bypass (1) would mean that nearly 5,000 patients would be expected to die of surgically related complications (0.5% per 1 million). On the other hand, using survey data from 2005 and estimating a per-year mortality rate of 3 per 1,000 patients with diabetes (9) would suggest that approximately 15,600 deaths would occur over 5 years in a cohort of 1 million medically managed patients with diabetes. Extrapolating from recent data that show an up to 90% reduction in diabetes-related mortality after gastric bypass (10) suggests that as many as 14,310 (90% of 15,600) diabetes-related deaths might be prevented by bariatric surgery over 5 years. These types of competing timelines and risks should be part of risk-benefit discussions with patients and policy makers. Whether that is happening now is unclear, and how best to present these complex data remains a challenge.

If one scales away the controversies brought about by prejudice against the disease, competing market interests, rational and irrational fear of surgery, and past errors of commission or mission in the performance of bariatric surgery, there can be no doubt that surgery for obesity is a successful, validated, legitimate treatment for an otherwise intractable disease.

CONCLUSIONS—Risks of bariatric surgery are easily quantifiable and can be divided into mortality and postoperative early and late complications. The operative mortality of bariatric surgery depends on many diverse factors—surgeon- and facility-related, patient-related, and procedure-related. Operative selection algorithms have attempted to match specific patients with a specific operation in order to, among other factors, minimize operative mortality.

The range of complications after weight-loss surgery depends on the specific procedure. Restrictive procedures (LAGB, VBG, SG) seldom affect bowel function and do not cause malabsorption. Operations that create malabsorption can cause a range of nutritional deficiencies.

Diabetes is strongly associated with increased morbidity and mortality following bariatric surgery. On the other hand, the benefits of bariatric operations in morbidly obese diabetic patients can hardly be exaggerated.

Consequently, conventional bariatric procedures are being used worldwide to treat type 2 diabetes in association with obesity, and increasingly among less obese or merely overweight patients. There is no single or standard procedure for management of morbidly obese diabetic patients.

Acknowledgments—No potential conflicts of interest relevant to this article were reported.

A.K. researched the data, contributed to the discussion, and wrote and edited the manuscript.

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