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PROCEEDINGS ARTICLE

Weighing in on bariatric surgery: who and when?

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Over two-thirds of the United States is overweight or obese, and over 5% of the country is morbidly obese. Numerous public health preventative measures have been established to help battle this public health epidemic. Surgical obesity treatment, although now gaining popularity, has been an underutilized treatment option for obesity. Patients with a body mass index (BMI) of >40 or $>35\,kg\,m^{-2}$ with two or more comorbid conditions are eligible for bariatric surgery. Currently, the three most popular bariatric surgeries are Roux-en-y gastric bypass, sleeve gastrectomy and gastric banding procedures, all overwhelmingly performed laparoscopically. The purpose of this article is to discuss the heterogeneity of bariatric surgery. In our practice, among 834 patients operated over a 4-year period (2006–2010), patients were of an average age of 45 years (16–73 years), 80.4% were female patients, 82.5% had private insurance, 61% were White, 17% were Hispanic and 9% were Black. Patients had an average BMI of $46.2\,kg\,m^{-2}$ ($30.1–75.3\,kg\,m^{-2}$), waist circumference of 133.6 cm (68.6–207.8 cm) and four preoperative comorbidities (0–11 comorbidities). Variation exists in surgeon practice patterns for preoperative weight-loss recommendations and complication rates based on surgery case volume. Despite variation in patient, surgeon and hospital characteristics, bariatric surgery outcomes are generally highly safe and effective.

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OBESITY AS A PUBLIC HEALTH CHALLENGE

Obesity is a complex disease that has become a major cause of morbidity and mortality in the United States. With numerous known comorbidities, obesity caused between 280 000 and 325 000 deaths in the United States in 2001.[1–3] Given the prevalence and extensive effects obesity has on the United States healthcare system, as well as on economy, obesity has quickly become the primary public health challenge in the United States. Primary interventions are focused on lifestyle modification through diet and exercise. However, in the Swedish Obesity Surgery Study, patients who received traditional lifestyle modification treatment experienced a mean body weight loss of only $\sim$2% during the up to 15-year follow-up period of patients.[4] Among patients for whom lifestyle modification alone is not effective or sufficient, doctors may re-assess goals or recommend pharmacological therapy. However, weight-loss medications have been found to be ineffective, with less than 5-kg reduction after 1 year, and are associated with side effects.[5]

Bariatric surgery is often listed as an ultimate option to the treatment of obesity. This may be due to the fact that surgery is not considered a traditional option to treating public health challenges.[6] However, throughout medical history, surgeons were often the first responders to public health crises, from the treatment of tuberculosis to the treatment of cancer. Given how effective and beneficial weight-loss surgery is for patients, primary care physicians should be comfortable discussing bariatric surgery options and results with patients.

WHO IS ELIGIBLE FOR WEIGHT LOSS SURGERY?

Weight loss surgery is a treatment option for patients who meet the 1991 National Institutes of Health Consensus guidelines of clinical severe obesity. Clinical severe obesity is generally defined as a body mass index (BMI) of >40 or $>35\,kg\,m^{-2}$ with two or more comorbid conditions.[7] The gastric band has now been approved for a BMI of $30–35\,kg\,m^{-2}$. There is a current NIH panel reevaluating criteria for bariatric surgery on the basis of comorbidity resolution and not solely due to weight.

Although all bariatric surgery patients meet these standard requirements before surgery, they come from very diverse backgrounds. Table 1 highlights the diversity of patients at our institution over the past 5 years. The average patient travels approximately 80 miles (2.3–3210 miles) to get to our Stanford clinic, and earns $62 400 annually ($15 000–277 000). In all, 80.4% of patients are women, and 82.5% of patients had private insurance. Whites, Hispanics and Blacks are the largest represented ethnic groups in our clinic, comprising 61, 17 and 9%, respectively, of our total patient population. Our patients were in the age group of 16 to 73 years, with the average age being 44.7 years. Our patients had an average BMI of $46.2\,kg\,m^{-2}$ ($30.1–75.3\,kg\,m^{-2}$), waist circumference of 133.6 cm (68.6–207.8 cm) and four preoperative comorbidities (0–11 comorbidities).

The most common comorbidities are diabetes (36%), hypertension (56%), hyperlipidemia (44%), gastroesophageal reflux disease (46%) and sleep apnea (42%). A total of 40% of these patients were diagnosed with clinical depression and/or were taking an anti-depressant (Table 2). These demographics are comparable to a typical bariatric surgery population.[8–9]

BARIATRIC SURGICAL OPTIONS

Although all bariatric surgeries assist in weight loss, they do so by different methods. This article will focus on three of the most common weight-loss procedures today: Roux-en-Y gastric bypass (RYGB), laparoscopic adjustable gastric banding and sleeve gastrectomy. At Stanford Hospital and Clinics, laparoscopic RYGB

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Table 1. Average preoperative patient demographics and ranges at Stanford University

	Average	*Minimum*	*Maximum*
Distance (miles)	78.8	2.3	3210
Income ($K)	62.4	15	277
Age at surgery (years)	44.7	16	73
BMI (kg m^{-2})	46.2	30.1	75.3
Waist circumference (cm)	133.6	68.6	207.8
Total preoperative comorbidities (%)	4	0	11
Preoperative weight loss (%EWL)	1.2	−19.4	23.7
Operative time (min)	167	32	500
LOS (days)	3.0	0	18

Abbreviations: BMI, body mass index; EWL, excess weight loss; LOS, length of stay.

Table 2. Preoperative prevalence (%) of most common comorbidities

Diabetes	36.5
Depression	39.9
GERD	45.5
Hyperlipidemia	44.1
Hypertension	56.5
Sleep apnea	41.8

Abbreviation: GERD, gastroesophageal reflux disease.

is the most common procedure (82.3%), followed by gastric banding (9.4%) and then the sleeve gastrectomy (8.3%).

Bariatric procedures can be hormonal and/or restrictive. Restrictive procedures decrease the storage capacity of the stomach by limiting the size of the proximal stomach or by creating a smaller stomach pouch. In hormonal procedures, absorption is decreased by bypassing the small bowel and by reducing the production of ghrelin, the hunger hormone, and increasing GLP-1, a hormone known to increase insulin sensitivity.

RYGB is a combination restrictive and hormonal procedure in which a small 30 cc proximal pouch is created from the stomach. The pouch is connected to the small intestine (30–50 cm from the ligament of Treitz). The small proximal pouch serves to restrict food intake, and bypassing part of the small intestine decreases absorption. Laparoscopic adjustable banding is a restrictive procedure in which a silicon band is placed around the proximal stomach outlet to restrict food intake. A sleeve gastrectomy is a restrictive procedure in which the stomach is constructed into a thin tube and most of the greater curvature of the stomach is removed.

Numerous studies have demonstrated conflicting evidence about ghrelin hormone levels before and after surgery. RYGB has been found to reduce ghrelin levels following surgery in some reports.[10–11] However, other studies have found that RYGB does not significantly reduce ghrelin levels postoperatively when compared with baseline.[12] Sleeve gastrectomy has also been found to reduce ghrelin levels in several studies.[12–13] In gastric band procedures, ghrelin levels were found to increase following surgery.[13–14]

BARIATRIC SURGERY OUTCOMES

The estimated number of bariatric surgical procedures increased from 13 365 in 1998 to 72 177 in 2002, with RYGB being the most common of all bariatric procedures, with current estimates closer to 175 000 annually.[15] Overall complication rates are reported to be between 7.3 and 14.1%.[16–18] The most common complications from bariatric surgery were wound infections and minor complications. RYGB had the highest complication rate (3.6%), followed by sleeve

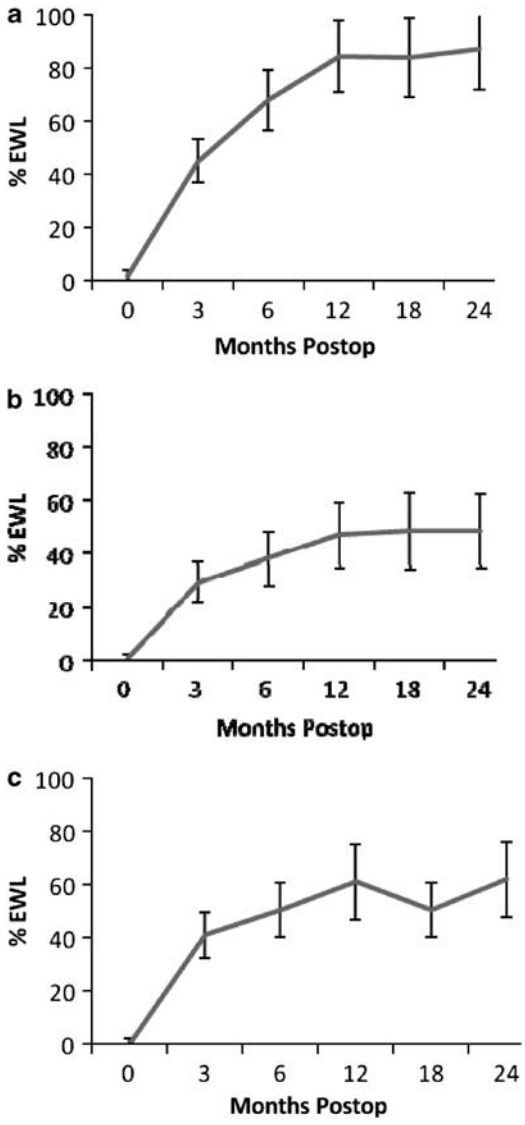

Figure 1. Average percent excess weight loss (% EWL) for RYGB (**a**) ($n = 573$), gastric band (**b**) ($n = 137$) and sleeve gastrectomy (**c**) ($n = 124$) over time. Data collected over the 4-year time period from 2006 to 2010 (mean, s.e.m.).

gastrectomy (2.2%) and lastly laparoscopic gastric band procedure (0.9%), in one Michigan-based study.[16] However, differences can be seen in hospital practice patterns. Flum *et al.*[17] found that the risk of mortality is lower for younger, female patients with higher surgical volume. These findings led centers of medicaid and Medicare Services to establish Bariatric Centers of Excellence based in large part on surgical volume standards.

Percent excess weight loss is defined as the change in weight from preoperative over the excess body weight, based on an ideal goal weight with a BMI of 27 kg m^{-2} (that is, the average BMI in the United States). At our institution, laparoscopic RYGB had the highest excess weight loss at 24 months post surgery (87.3%). Gastric banding and sleeve gastrectomy resulted in a percent excess weight loss of 48.3% and 62.1%, respectively, at 24 months post surgery (Figure 1). Results were comparable to other studies that have a RYGB percent excess weight loss of 68.2 and 61.6% for gastric banding procedures.[18] However, there is large heterogeneity in patient outcomes following each surgery.

There may be variation in surgeon practice, such as recommendation for preoperative weight loss, due to the conflicting

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Table 3. Percent improvement (s.d.) of cardiac risk factors that improved most

	RYGB	*Gastric band*	*Sleeve gastrectomy*
HDL cholesterol	26 (35)	13 (24)	20 (26)
Triglycerides	28 (35)	7 (53)	7 (70)
High sensitivity C-reactive protein	24 (58)	22 (69)	18 (109)
Fasting insulin	68 (26)	47 (35)	64 (28)

Abbreviations: HDL, high-density lipoprotein; RYGB, Roux-en-y gastric bypass.

evidence of improved outcomes for patients. It has been shown that weight loss before the surgery may reduce operative time by 37 min.[19] Preoperative weight loss was not found to reduce complication rates, but did correlate with more rapid or increased postoperative weight loss.[20–23]

Variation and heterogeneity may exist between the different procedures in terms of outcomes. Previous studies have shown significant improvement in biochemical cardiac risk factors in patients undergoing bariatric surgery. In RYGB patients, total cholesterol, low-density lipoprotein and high-density lipoprotein (HDL) cholesterol, triglycerides, triglyceride/HDL cholesterol ratio, homocysteine, high-sensitivity C-reactive protein, fasting insulin and hemoglobin A1C improved significantly by 12 months post surgery.[24] At Stanford, patients who underwent gastric bypass saw the greatest percent improvements in fasting insulin (−68.3%), triglycerides (−27.5%), HDL cholesterol (+26.1%) and high-sensitivity C-reactive protein (−23.8%). Among gastric band patients, HDL cholesterol, triglyceride, triglyceride to HDL cholesterol ratio, homocysteine, high-sensitivity C-reactive protein, fasting insulin and hemoglobin A1C improved significantly.[24] Similar to RYGB, although not as large an improvement, for gastric banding, the greatest improvements were seen with fasting insulin (−47.1%), high-sensitivity C-reactive protein (−21.9%) and HDL cholesterol (+13.4%). Sleeve gastrectomy patients had a significant improvement in their hemoglobin A1C, HDL cholesterol and triglycerides, but not total cholesterol and low-density lipoprotein cholesterol 12 months after surgery.[25] They also had the greatest improvement in fasting insulin,(−63.8%) HDL cholesterol (+20.3%) and high-sensitivity C-reactive protein (−17.9%). However, as with other outcomes, there is a large range in percent improvements (Table 3).

Not only did cardiac risk factors improve significantly in patients, but bariatric surgery also assisted in nearly complete comorbidity resolution. In one meta-analysis, diabetes was completely resolved in 76.8% of patients and resolved or improved in 86.0%. Hyperlipidemia improved in 70% of patients, hypertension resolved in 61.7% of patients and obstructive sleep apnea resolved in 85.7% of patients.[18] Furthermore, bariatric surgery has been associated with a lower number of cardiovascular deaths (28/2010 patients versus 29/2037 controls) with a hazard ratio of 0.47 (95% confidence interval: 0.29–0.76).[26–27] However, deaths related to accidents and suicides were 58% higher in bariatric surgery groups than in control groups.[27] Therefore, physicians must educate patients on drug and alcohol abuse that may be associated with trauma and suicides. After surgery, patients' alcohol sensitivity changes as demonstrated in this study.[28]

CONCLUSIONS

Bariatric surgery is a durable method for weight loss in clinically obese patients; however, patient demographics, surgeon practice patterns and outcomes are not equal in all cases. Bariatric surgery patients are part of a diverse population with individual needs. Patients should be treated at high volume centers for the lowest risk of complications and should be educated about the diversity in outcomes in order to set realistic patient expectations.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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