LAPAROSCOPIC SURGERY FOR MORBID OBESITY

Philip R. Schauer, MD, and Sayeed Ikramuddin, MD

Although many types of operations for the treatment of clinically severe obesity have been developed over the last four decades, only a few have been considered successful. A successful weight-loss operation has two major goals: significant magnitude and duration of weight loss, and a reasonably low perioperative and long-term complication rate. In general, operations leading to the greatest amount of weight loss also have higher short-term and long-term complications. Thus, the risk/benefit ratio must be considered when assessing bariatric operations. Two major advances in the last decade characterize the current era of bariatric surgery. The first relates to the accumulation of several outcome studies that provide reliable expectations of long-term weight loss and complications for the major bariatric operations. This information allows surgeons to match patients' needs and risk with appropriate procedures. The second advance, and the focus of this article, is the development of less invasive bariatric operations using laparoscopic techniques. Laparoscopic bariatric surgery is a major advance because it improves outcomes by reducing perioperative morbidity, recovery, and in some cases even late complications (e.g., hernia).

A survey of the membership of the American Bariatric Surgery Society in 1999 (Table 1) describes the frequency of bariatric operations performed in North America. Two major trends in the last decade are readily recognized. First, Roux-en-Y gastric bypass (RYGBP), with a frequency of 70%, has superseded the gastric restrictive operations

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From the Department of Surgery, The University of Pittsburgh; and the UPMC Minimally Invasive Surgery Center, Pittsburgh, Pennsylvania

Table 1. CHOICE OF BARIATRIC PROCEDURE FOR SURGEONS IN THE USA AND CANADA*

Operation	Frequency Performed (As % of Total No. of Procedures)
Roux-en-Y gastric bypass (RYGB)	70
Biliopancreatic diversion	12
Vertical banded gastroplasty (VBG)	7
Gastric banding	5
Silastic ring gastroplasty	4
Laparoscopic bariatric surgery	3

ASBS = American Society of Bariatric Surgery.
*ASBS Survey, 1999.

(16%), including vertical banded gastroplasty (VBG), gastric banding (GB), and Silastic ring gastroplasty, as the preferred operation, with the malabsorption operations represented by the biliopancreatic diversion (BPD) showing a frequency of 12%. The ascendancy of RYGBP is likely driven by reports of unsatisfactory long-term weight loss and rates of reoperation after VBG.[32, 66] Furthermore, a recent study from the Mayo Clinic showed only a 26% success rate for VBG after ten years of followup.[3] Thus, RYGBP has become the new gold standard for bariatric surgery, at least in North America. The second major trend is the emergence of laparoscopic procedures, which had a frequency of only 3% in 1999 but which will likely increase in frequency to dominate bariatric surgery in the near future.

Laparoscopic approaches to bariatric operations, including VBG, adjustable Silastic GB, and gastric bypass all emerged during the early to mid-1990s in the wake of laparoscopic cholecystectomy. Because of the complexity of these procedures in morbidly obese patients, the transition to common practice has been slower than that of some second-generation procedures, such as laparoscopic hernia repair and Nissen fundoplication. Currently there is sufficient early experience to review technique and outcomes of three bariatric procedures: laparoscopic VBG, GB (with adjustable bands), and gastric bypass. Laparoscopic malabsorption operations are just beginning to emerge. Hybrid procedures using hand-assisted laparoscopic techniques have developed with the aim of providing similar benefits to those seen in completely laparoscopic procedures. In laparoscopic bariatric surgery, it is important to have adequate training both in advanced laparoscopic surgery and bariatric surgery. The goal of this article is to review the status of the emerging field of laparoscopic bariatric surgery, to discuss developmental issues, particularly regarding technique and training, and finally to summarize the present and future roles of laparoscopic bariatric operations. Much of the information is derived from a recent review by the authors, with appropriate updates.[54]

GOLD STANDARD FOR OPEN BARIATRIC SURGERY

In assessing new laparoscopic bariatric operations, it is appropriate to establish benchmark outcome goals for comparison. The RYGBP is most suitable for comparison, because significant evidence exists documenting both short-term and long-term outcomes and it is considered by most North American surgeons to have the most favorable risk-to-benefit profile. Table 2 demonstrates selected series of open RYGBP results published primarily in the last decade with key outcome parameters.* These studies varied considerably regarding which outcome parameters were reported. Notably absent are data reflecting operative time and perioperative recovery, such as length of hospital stay and time of return to work (not reported in any of the studies). Routinely reporting data that reflect recovery after surgery has been considered important only recently. Collectively these studies suggest that open RYGBP results in a hospital stay ranging from four to eight days, perioperative complication rate of 3%–20%, a mortality rate of about 1%, a pulmonary embolus rate of 0%–3%, a leak rate of 0%–5%, and hernia rate of 5%–24%. Operative time was not reliably reported in any of the studies. Long-term weight loss at 5 to 15 years appears to be 49%–62% of excess body weight.

RATIONALE FOR A LESS INVASIVE APPROACH TO BARIATRIC SURGERY

Reduction in perioperative morbidity is the major advantage of the laparoscopic approach. Although perioperative morbidity for bariatric procedures via laparotomy has steadily diminished, cardiopulmonary and wound complications remain a major problem.[26, 38] Furthermore, recovery after these bariatric procedures may take many weeks or months. The access laparotomy contributes to the duration of recovery and perioperative morbidity. By minimizing the access incision, a laparoscopic approach to bariatric procedures has a strong potential to significantly reduce recovery time and morbidity. Because conventional bariatric procedures require extended abdominal incisions in patients with generally high comorbidity, the relative reduction in perioperative morbidity after laparoscopic bariatric procedures may even be greater than what has been observed for laparoscopic cholecystectomy.

Compared to access by laparotomy, laparoscopic approaches to major abdominal operations have been shown to reduce organ-system impairment, resulting in significantly reduced perioperative morbidity and recovery time; these benefits should occur with laparoscopic bariatric procedures. The hypermetabolic stress response of surgery, characterized by increased energy expenditure, myocardial O_2 demand, pulmonary workload, and renal workload is initiated by tissue injury and adversely affects most organ systems directly or indirectly, contributing

*7, 9, 16, 20, 22, 28, 33, 34, 37, 47, 69.

Table 2. OUTCOMES FOR OPEN GASTRIC BYPASS: SELECTED SERIES

	N	Patient Size (BMI, kg, or % IBW)	OR Time (min)	Hospital Stay (d)	Early Complication Rate (%)	Mortality (%)	PE Rate (%)	Leak Rate (%)	Hernia (%)	Followup (mo)	Weight Loss
Mason 1969[37]	26	42	—	—	19	7.7	3.4	0	11.5	12	43 kg
Griffin 1981[20]	402	134 kg	—	—	4.2	0.75	0.25	5.47	3.5	6	35 kg
Linner 1982[28]	174	126 kg	—	—	10.4 (all)	0.57	0	0.57	0	24	64% EWL
Sugerman 1989[69]	182	213%	—	6–7*	—	1	0	1.6	18*	12	67% EWL
Hall 1990[22]	99	198%	120	8	20	0	3	0	2	36	67% lost >50% EBW
Brolin 1992[7]	90	62	—	—	5	0	1.1	0	6.6	43	64% EWL
MacLean 1993[34]	106	50	—	—	—	0	—	5.6	—	33	58% lost >50% EBW
Poires 1995[47]	608	50	—	5–6*	25.5	1.5	—	—	23.9	168	49% EWL
Capella 1996[9]	560	52	—	—	1	0	0	0†	—	60	62% EWL
Fobi 1998[16]	944	46	—	4*	2.7	0.4	0.6	3.1	4.7	24	80% EWL
MacLean 1999[33]	243	49	—	—	—	0.41	—	—	16	66	BMI 44→29‡

Data from Schauer PR, Ikramuddin S, et al. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. Ann Surg 232:515–529, 2000.

BMI = body mass index; d = days; EBW = excess body weight; EWL = excess weight loss; IBW = ideal body weight; min = minutes; mo = months; PE = pulmonary embolism; — = not reported.

*As reported by the investigator, without mean and standard deviation of the mean.

†One subphrenic abscess.

‡Change in BMI for patients with intital BMI 40–50.

to perioperative morbidity.[53] The magnitude of this stress response is directly related to the magnitude of tissue injury. Studies comparing the stress response of open versus laparoscopic procedures by measuring mediators such as catecholamines, cortisol, glucose, cytokines, and other acute-phase reactants have demonstrated that the laparoscopic approach results in attenuation of the hypermetabolic response.[59] Through mechanisms that are not clearly understood, surgical injury and consequent hypermetabolism also adversely affect postoperative immune function. Animal and human studies have demonstrated reduced impairment of immune function, particularly cell-mediated immunity after laparoscopic compared to that of open procedures.[72] Although not proven, better immune function may translate to reduced postoperative infections. Probably because of reduced myocardial O_2 demand, cardiac complications appear to be reduced after laparoscopic operations compared to those of laparotomy.[77]

Preserved pulmonary function is the most well-documented benefit of laparoscopic surgery, with comparatively less impairment in postoperative ventilation, total lung capacity, and oxygen saturation, resulting in fewer pulmonary complications.[58] Other organ systems seem to benefit from laparoscopy. Postoperative ileus, which is a major contributor to postoperative morbidity and hospital stay, is less common and of shorter duration following laparoscopic procedures.[18] Laparoscopic access has dramatically reduced the incidence and magnitude of wound-related complications including hematomas, seromas, infections, hernias, and dehiscences.[77] Adhesion-related morbidity such as bowel obstruction, infertility, and chronic abdominal pain are forgotten and underrated complications of laparotomy because they occur unpredictably years later. Reduction of postoperative adhesion formation has been demonstrated after laparoscopic operations compared to laparotomy operations, and although not proven, related complications should decrease following laparoscopic procedures.[31] Finally, some retrospective studies involving laparoscopic versus open cholecystectomy include evidence that operative mortality, particularly in high-risk patients, may be reduced by the laparoscopic approach.[65, 77]

It has been widely assumed that severely obese patients are generally at higher risk than nonobese patients for preoperative complications. Evidence from the literature to support this claim, however, is mixed and unclear.[11, 48] Many of these studies are inadequate because of insufficient sample size, or failure to include patients with severe obesity or to differentiate severe obesity from milder forms. Nevertheless, morbidly obese patients are clearly at increased risk for developing numerous medical disorders that adversely affect surgical outcomes. Cardiovascular risk, pulmonary risks, rates of thromboembolic events, risk of postoperative infections, and particularly rates of wound complications have been proven higher in at least subpopulations of morbidly obese patients[6, 12, 25, 40, 49, 67, 68, 73] Thus, despite good or acceptable outcomes for open bariatric operations, the well-documented benefits of laparoscopic surgery in nonobese patients may be even more profound in severely obese patients who are at higher risk for cardiopulmonary, infectious, and wound-related morbidity. In the nonbariatric literature, although laparoscopic approaches, especially laparoscopic cholecystectomy, have been proven to be generally safe and effective for morbidly obese patients, there are few direct comparisons to open procedures.[61] One retrospective study comparing laparoscopic cholecystectomy to open cholecystectomy in morbidly obese patients demonstrated that the laparoscopic approach was associated with a significant reduction in morbidity and mortality in high-risk, diabetic patients.[64] In summary, strong evidence suggests that laparoscopic approaches to bariatric surgery are likely to have significant benefits for severely obese patients that more than justify the effort to develop and perfect these techniques.

LAPAROSCOPIC VERTICAL BANDED GASTROPLASTY

Most laparoscopic versions of VBG are derived from the Mason gastroplasty.[36] The current experience with a laparoscopic approach to VBG (or Lap VBG) comes predominantly from a few centers in Europe. US surgeons appear reluctant to consider Lap VBG, perhaps because long-term weight loss after open VBG appears less favorable than that of Roux-en-Y gastric bypass.[3, 32, 66] Furthermore, complications such as gastroesophageal reflux disease (GERD, 16%) and frequent vomiting (21%) are common.[3]

To date, only a few studies of Lap VBG with short followup (< 3 years) have been published, mostly by European surgeons.[1, 10, 19, 29, 43, 52, 71] (Tables 3 and 4). These studies should be interpreted in light of the fact that most of the patients are European and the mean BMI is relatively low (low 40s). Furthermore, many investigators have held that for unclear reasons, European patients respond better to gastric restrictive procedures than do US patients. Mean operative time ranges from 60 to 120 min with conversion rates from 1% to 5% and a mean hospital stay of 1 to 4 days. The most common operative complications include gastric perforation (0%–2%) and bleeding (0%–2%). The most common early complications (< 30 days) include outlet stenosis (0%–2%), DVT/PE (0%–2%), fistula (0%–1.5%), subphrenic abscess (0%–2%), bleeding (0%–1%), and pulmonary complications (0%–3%). Wound infections were quite uncommon (< 3% in most series) and relatively minor. Late complications after Lap VBG that may require reoperation include new onset gastroesophageal reflux (0.5%–12%), staple–line fistula (0%–3%), food intolerance (0%–2%), outlet stenosis (0%–2%), pouch enlargement (0%–2%), and port-site incisional hernia (0%–0.5%). Mortality varied from 0% to 1.7%, with pulmonary embolus being the most common cause. For unclear reasons, weight loss with followup less than 3 years in most series appears to be slightly higher than reported for open VBG (i.e., 40%–50% excess weight loss).

One of the few comparative studies, by Azagra et al from Belgium, reported results of a randomized prospective trial of laparoscopic versus

Table 3. LAPAROSCOPIC VERTICAL BANDED GASTROPLASTY (VBG)

Author	N	Female (%)	BMI	OR Time (min)	Conversions (%)	Early Complication Rate (%)	Late Complication Rate (%)	Hospital Stay (d)	Followup (mo)	Weight Loss
Alle	261	85.4	43.3	102	1.1	1.9	5.7	4	28 mean	75% @ 18 mo
Goergen	203	79.8	43.0	120	2.8	2.9	2.0	4	NI	NI
Toppino	170	NI	43.9	95	0.6	4.7	4.0	NI	1–36	61% @ 3 yrs
Lonroth	105	75.2	41.0	NI	5.7	1.9	1.9	3–5	6	↓25 kg mean @ 6 mo
Salval	87	86.0	43.8	NI	0.0	12.6	7.4	NI	6–18	75% @ 18 mo
Näslund	60	83.0	44.4	115	25.0	6.7	2.2	3	23 mean	BMI ↓ 10.9 @ 36 mo
Champion	27	93.0	45.7	60	3.7	0.0	7.4	23 hrs	12	63% @ 12 months

NI = not indicated; BMI = body mass index; OR = operating room.

Table 4. COMPLICATIONS AFTER LAPAROSCOPIC VERTICAL BANDED GASTROPLASTY

	Abscess N (%)	Leak N (%)	Fistula **	PE N (%)	Pulmonary N (%)	Stenosis N (%)	Reflux N (%)	Bleeding N (%)	Hernia N (%)	Food Intolerance N (%)	Pouch Dilatation N (%)	Mortality (%)
Alle	0 (0)	0 (0)	2 (.8)	1 (.4)	1 (.4)	5 (1.9)	0 (0)	0 (0)	0 (0)	NI	NI	0.4 2nd PE
Goergen	0 (0)	0 (0)	3 (1.5)	0 (0)	0 (0)	0 (0)	1 (0.49)	1 (0.49)	1 (0.49)	0 (0)	0 (0)	0.0
Toppino	1 (0.59)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1.8)	1 (0.59)	4 (2.4)	0 (0)	2 (1.2)	3 (.59)	0.0
Lonroth	0 (0)	1 (.95)	1 (.95)	1 (.95)	0 (0)	1 (.95)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.95 2nd PE
Salval	2 (2.3)	1 (1.1)	0	2 (2.3)	3 (3.4)	2 (2.3)	2 (2.3)	0 (0)	0 (0)	0 (0)	0 (0)	1.1 2nd PE
Näslund*	0 (0)	0 (0)	0 (0)	0 (0)	3.3	0 (0)	7 (12)	0 (0)	0 (0)	12 (20)	1 (1.7)	1.7 @ 6 mo*
Champion	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.0

*Noted as unrelated to the surgery.
**Staple line fistula.
NI = not indicated; PE = pulmonary embolism.

open VBG in a series of 68 patients (34 laparoscopic) with a mean BMI of 43 kg/m^2.[2] The conversion rate was 12% and the operating time was significantly longer in the laparoscopic group (150 min versus 60 min; $p = .001$). Early major postoperative complications were equivalent (6.6% versus 7.8%), but there were fewer early minor postoperative complications (wound infections) in the laparoscopic group (3.3% versus 10.8%). The incisional hernia rate was 15.8% in the open group versus 0% on the laparoscopic group ($p = 0.4$). Although weight-loss data were not reported, the study indicated no difference in weight loss between the groups with short followup (< 2 years).

Collectively, these early studies suggest benefits in perioperative morbidity with the laparoscopic approach to VBG related to wound complications and recovery in particular. Several studies demonstrated a higher rate of technical complications with the laparoscopic approach (early in their surgeons' experience) compared to what has been reported with open VBG. This may represent a learning curve for the lap VBG similar to what has been observed with most laparoscopic procedures. Weight loss results appear comparable to or better than expected results of open VBG, perhaps because of careful selection or differences between European and American eating habits. Followup, however, is too short to draw significant conclusions.

Technique of Laparoscopic Vertical Banded Gastroplasty

Laparoscopic approaches to VBG vary slightly among surgeons but are generally adaptations of the Mason VBG for open surgery described in 1982.[36, 60] Patients are placed in reverse Trendelenburg and are either supine with the surgeon on the right and assistant on the left, or in a modified lithotomy position with the surgeon between the patient's legs. Five ports (5–10 mm) are placed in the upper abdomen and a self-retaining retractor holds the liver lobe (Fig. 1A). A window in the peritoneal fold at the angle of *His* is created with electrocautery or ultrasonic dissection. The intended site for circular stapler (EEA stapler) is measured 6 cm below the angle of *His* and 3 cm from the lesser curvature (Fig. 1B). A window is made at this level through the lesser omentum adjacent to the nerve of Latarjet. With a 32 French Bougie or flexible endoscope in place against the lesser curvature, a straight needle with heavy suture is passed through the retrogastric space, then transgastrically just lateral to the Bougie (Fig. 1C). The suture is tied to the tip of the anvil and used to guide passage of the anvil transgastrically. After removal of the spike from the anvil, the EEA stapler shaft is passed through a 30-mm port and attached to the anvil. Firing the stapler creates a circular transgastric defect (Fig. 1D). The endoscopic GIA linear stapler is inserted transgastrically through the defect up toward the angle of *His*, abutting the Bougie in place against the lesser curvature. The stomach is then stapled and divided; two applications may be

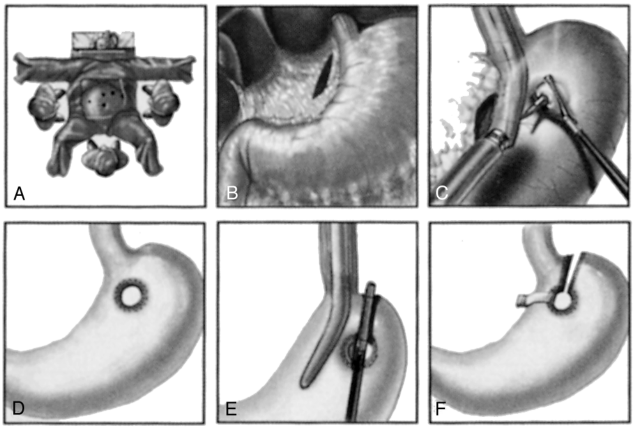

Figure 1. Laparoscopic vertical banded gastroplasty (VBG). *A*, Set-up and port placement for laparoscopic VBG. *B*, Dissection and measurement for circular stapler. *C*, Transgastric passage of needle with attached end-to-end anastomosis (EEA) anvil. *D*, Creation of transgastric defect with EEA. *E*, Stapling and division of stomach. *F*, Band placement. (*From* Schauer PR, Ikramuddin S: Laparoscopic surgery for severe obesity. Probl Gen Surg 17:39–54, 2000; with permission.)

necessary (Fig. 1E). As desired, the staple line may be oversewn. Alternatively, a linear stapler with no knife may be used to produce a staple line without gastric division. A 1-cm by 6-cm band of polypropylene or polytetrafluoroethylene (Gor-Tex [Gore, Flagstaff, AZ]) is placed firmly around the pouch outlet with the 34 French Bougie in place, and sewn to itself using interrupted nonabsorbable sutures (Fig. 1F). After inspection, the port sites are closed to complete the procedure.

LAPAROSCOPIC GASTRIC BANDING*

Laparoscopic gastric banding (LGB) was first introduced outside the US in the early 1990s. It is a purely gastric restrictive procedure that involves the use of an adjustable silicone band placed around the gastric cardia to create a small gastric pouch (15 ml) with a narrow outlet similar in concept to that of the VBG. It is a modification of the original open adjustable silicone gastric band (ASGB) developed by Kuzmak.[27] Presently in the United States, LGB is considered an experimental proce-

*The Lap Band device (BioEnterics, Carpinteria, CA) was approved by the FDA in June 2001. BioEnterics anticipates US introduction within 2 months of approval. Product labeling requires that surgeons have advanced laparoscopic surgical skills along with bariatric experience or training. There also must be an established bariatric patient support program at each site with a commitment to long-term care of patients. Surgeons and program coordinators must complete a training program that includes workshops and proctoring.

dure and is under FDA-directed study at select centers. Three hundred patients have been enrolled, and patients are currently undergoing a mandatory period of three years of followup before the FDA will consider approval of this implantable device. The two commercially available products sold only outside the United States include the Lap-Band (Bioenterics, Carpinteria, CA) and the Swedish Band (OBTECH, Zug, Switzerland) (see Fig. 2A, B). The bands have an inflatable reservoir that can be adjusted postoperatively by percutaneous access of a subcutaneous port placed deep in the abdominal wall. Injection or withdrawal of saline from the port allows for adjustment of the gastric luminal diameter, which can be measured by barium contrast evaluations. Laparoscopic banding thus differs from VBG in that the band diameter may be increased to minimize side effects such as vomiting, or may be decreased to enhance weight loss.

Nearly a decade of experience with LGB has been accumulated outside of North America, with an estimated patient experience of more than 60,000. Several large series (> 200 patients) with intermediate followup (all ≤ 5 years) have been published mostly by European surgeons (Tables 5–7)[4, 13–15, 21, 45, 80] Preliminary results of the US FDA trial by Greenstein et al represent the experience of the only North American study to date.[21] Operative times ranging from 35 to 90 min appear less than those of Lap VBG, and conversion rates are low (0%–4%). The most common operative complications include gastric perforation (0%–1%) and bleeding (0%–1%). The most common early complications (< 30 days) include food intolerance (0%–11%), wound infections (0%–1%), DVT/PE (0.8%), pneumonia (0.8%), and bleeding (0.5%). Late complications of the band that frequently require reoperation are relatively common and include food intolerance (13%), band slippage (2.2%–8%), pouch dilatation (5%), and band erosion (1%). Improved fixation techniques appear to lessen band slippage. Port-specific complications include infection (1%–2%), twisting (0.5%), and tube defects (0.5%), and generally require replacement. Reoperation is as high as 13%, with band slippage being the most common cause. Whether the reoperation rate stabilizes or continues to increase remains to be seen. Reoperation for failure of adequate weight loss was not reported but may add significantly to the reoperation rate. Mortality for lap banding appears quite low (0.06%).

Some surgeons have noted the occurrence of significant esophageal dilatation after band tightening that does not appear to resolve completely after loosening the band.[41] This psuedo-achalasialike condition has potentially harmful long-term implications for esophageal motility. Weiss et al showed that in 28% of patients, LGB resulted in a twofold increase in impaired esophageal motility, a twofold decrease in lower esophageal sphincter (LES) relaxation, and a marked increase in esophageal diameter (28% of patients), even though patients denied dysphagia (Fig. 3).[76] The significance of these findings remains unclear, but they suggest that long-term surveillance of esophageal motility with motility studies and barium swallow may be indicated until the issue is resolved.

Table 5. LAPAROSCOPIC BANDING

Author	N	Female (%)	BMI	OR Time (min)	Conversions N (%)	Early Complications N (%)	Hospital Stay (d)	Reop (%)	Follow-up	EWL (%)
Zimmermann	894	85.2	42.0	35	1 (0.11)	3 (0.33)	3.0	2	1 y	40
Belachew*	550	73.0	43.0	62	5 (1.1)	2 (0.4)	NI	56	5 y	50
Dargent	500	80.0	43.0	NI	NI	4 (0.8)	NI	3.6	28 mo	65 (2 y)
Fielding	335	82.0	46.7	71	3 (0.9)	7 (2.1)	1.4	3.6	1.5 y	62
O'Brian	277	88.0	44.5	57	5 (1.8)	12 (4.3)	3.9	4***	4 y	70
Favretti	260	72.0	45.5	90	10 (3.8)	NI	2.0	4.2	NI	NI
Greenstein	250	NI	48.0	NI	NI	14 (5.6)	NI	5.2**	5 y	42

*Personal communication with Dr. Mitiku Belachew, 10/8/99, Cedars Sinai Medical Center.
**Reoperation for slippage early or late not exactly indicated; 900 patients but the band was not placed in 6 patients.
***Data no differentiation of open vs laparoscopic. N = 302 (25 patients were open); NI = not indicated; EWL = excess weight loss.

Table 6. EARLY COMPLICATIONS AFTER LAPAROSCOPIC BANDING

Author	Gastric Perf*** N (%)	Bleeding	Food Intolerance	DVT/PE	Wound Infection	Pneumonia	Band Slippage N (%)	Mortality N (%)
Zimmer*	2 (intraop)*	2 (.22%)	0 (0%)	0 (0%)	0 (0%)	0 (0)	0 (0)	1 gastric necrosis
Belachew**	1 (.29)	0 (0%)	41 (11.7%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Dargent	1 (.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Fielding	0 (0)	0 (0)	0 (0)	0 (0)	4 (1.2)	0 (0)	2 (0.6)	0 (0)
O'Brian	0 (0)	0 (0)	0 (0)	0 (0)	1 (.4%)	0 (0)	0 (0)	0 (0)
Favretti	1 (0.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0.7)	0 (0)
Greenstein	NI	NI	NI	NI	NI	NI	13 (5.2)	1 (med intox)

*For this reason the band was not placed
**3 abscesses abdominal/thoracic
***Perforation
DVT/PE = deep venous thrombosis/pulmonary embolus

Table 7. LATE COMPLICATIONS AFTER LAPAROSCOPIC BANDING

Author	Food Intolerance N (%)	Reflux N (%)	Band Slippage N (%)	Pouch Dilatation N (%)	Band Erosion N (%)	Port Complications N (%)	Reop Rate N (%)
Zimmer	NI	NI	49 (5.5)	49 (5.5)	NI	23 (2.5)	2
Belachew	46 (13.1)	NI	28 (8.0)	18 (5.1)	0 (0)	NI	13.1% of 2.0%
Dargent	NI	NI	NI	25 (5)	2 (.4)	7 (1.4)	3.6
Fielding	0 (0)	1 (0.3)	12 (3.6)	NI	0 (0)	5 (1.5)	7.1
O'Brien	0 (0)	NI	27 (8.9)**	NI	0 (0)	1 (0.37)	8.9*
Favretti	0 (0)	NI	6 (2.3)	NI	1 (.38)	5 (1.9)	5.4
Greenstein	NI	NI	NI	NI	NI	NI	NI

*For prolapse of the stomach through the band.
**Denominator 302 pts.
NI = Not indicated clearly in the data.

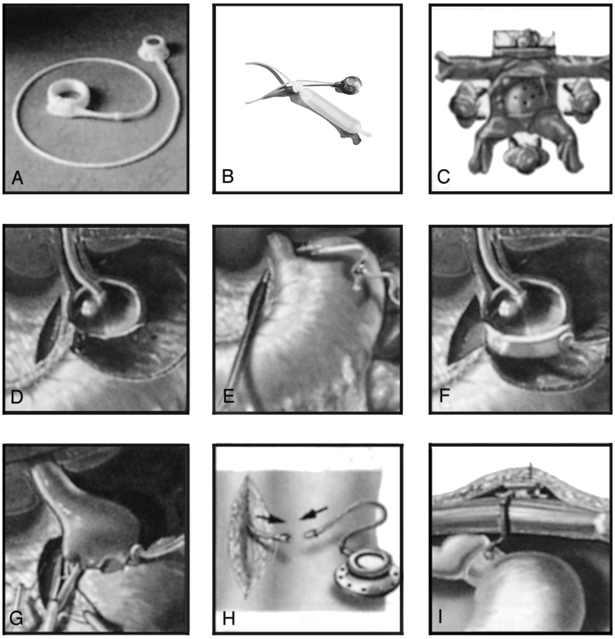

Figure 2. Laparoscopic gastric banding. *A*, Lap-Band (BioEnterics, Carpinteria, CA). *B*, Swedish Band (OBTECH, Barr, Switzerland). *C*, Set-up and port placement for laparoscopic banding. *D*, Placement of gastric calibration tube and lesser curve dissection. *E*, Creation of retrogastric tunnel and insertion of band. *F*, Closure of band around calibration tube. *G*, Placement of seromuscular sutures around band. *H and I*, Connection and implantation of band tubing and port. (*From* Schauer PR, Ikramuddin S: Laparoscopic surgery for severe obesity. Problems in General Surgery 17:39–54, 2000; with permission; *Fig. 2B Courtesy of* OBTECH, Baar, Switzerland.)

Weight loss after LGB with followup less than three years in most series appears similar to that achieved with the VBG (i.e., 40% to 60% excess weight loss) although weight loss up to 87% at two years has been reported.[75] Similar to the lap VBG studies, most LGB studies involve European patients with a relatively low mean BMI (low 40s). Long-term results for patients in the US will be deferred until the FDA study is complete; however, intermediate results show an excess weight loss of 39% at two years in 50 eligible patients.[21] Unlike VBG, an advantage or disadvantage of lap-adjustable banding is that multiple adjustments of the band diameter (which can be labor-intensive especially if confirmed by radiology) are necessary throughout the postoperative period and long-term followup.

These preliminary studies suggest that lap banding techniques are associated with a short hospital stay, rapid recovery, and minimal perioperative morbidity and mortality. Potential advantages include adjustability and complete reversibility upon removal of the device, with no stapling or dividing native tissue required. Disadvantages include the development of device-specific complications such as band migration, band erosion into the GI tract, esophageal dilatation, and foreign body reaction. The role of LGB is currently limited in the United States until the FDA trial is complete and data regarding efficacy and complications have been scrutinized.

Technique of Laparoscopic Gastric Banding

The patient is placed in lithotomy position and in reverse Trendelenburg. Six ports are placed, with one reserved for a liver retractor to elevate the left lobe (Fig. 2C).[4] A gastric calibration tube is placed through the mouth into the stomach and the balloon is inflated to 15 ml before it is pulled up to the gastroesophageal junction. A site on the lesser curvature is chosen to begin dissection, corresponding to the widest circumference of the balloon (Fig. 2D). After the balloon is deflated, a retrogastric tunnel is created using blunt dissection and staying above the peritoneal reflection of the omental bursa, avoiding the lesser sac. Additional dissection is carried out laterally near the angle of *His* to complete the retrogastric tunnel. A specially designed device is then inserted through the retrogastric tunnel and used to grasp the band tubing and pull it around the stomach (Fig. 2E). The band is then locked

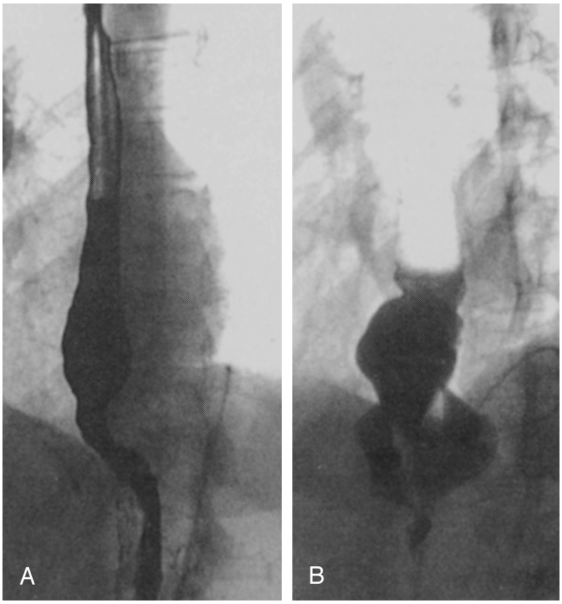

Figure 3. *A and B*, Esophageal dilatation after laparoscopic gastric banding. (*From* Weiss HG, Nehoda H, Labeck B, et al: Treatment of morbid obesity with laparoscopic adjustable gastric binding affects esophageal motility. Am J Surg 180:479–482, 2000; with permission.)

in place. The calibration tube is then reinserted into the proper position and the band closed around the tube (Fig. 2F). The calibration tube allows for proper stoma calibration. At least four sutures are then placed in the seromuscular layer of the stomach just proximal and distal to the band to keep it in proper position (Fig. 2G). The injection port is then connected to the band tubing and implanted into the left rectus sheath (Fig. 2H, I).

LAPAROSCOPIC GASTRIC BYPASS

The gastric bypass operation for severe obesity is now the most commonly performed bariatric operation in the United States and has evolved considerably (with many variations) since the loop gastric bypass described by Mason in 1969.[37] It is most commonly performed with a retrocolic Roux-en-Y anastomosis to a small (15–30 ml) stapled or divided gastric pouch. Laparoscopic approaches to gastric bypass simulate the open procedure. Lap RYGBP was first described by Wittgrove, Clark, and Tremblay.[79] Their technique involves creation of a 15- to 30-ml gastric pouch isolated from the distal stomach; a 21-mm stapled, circular anastomosis (internal diameter 12–14 mm), a 75-cm retrocolic, retrogastric Roux-limb, and a stapled side-side jejunojejunostomy. They employ a pull-wire technique to advance the EEA anvil through the mouth and out the gastric pouch. They have reported on their noteworthy experience with 500 patients and followup of up to five years.[78] Tables 8 and 9 demonstrate results of reported series of Lap RYGBP.[10, 17, 24, 55, 78] Most groups use five to six access ports (5 mm–15 mm) and construct an isolated small gastric pouch (15–30 ml) with a retrocolic, retrogastric Roux-limb (75 cm) and stapled jejunojejunostomy. Some groups extend the Roux-limb length to 150 to 250 cm for the superobese. Significant variations include Lonroth et al, who initially reported on their experience with a loop gastrojejunostomy instead of Roux-en-Y connection.[30] The loop gastrojejunostomy technique, originally described by Mason, has largely been replaced in the last 20 years by Roux-en-Y construction because it more effectively diverts bile and pancreatic juice. Gagner and colleagues use an antecolic, antegastric Roux-limb. The antecolic approach obviates the technically challenging task of creating the retrocolic tunnel, but there is concern that it may create excessive tension on the gastrojejunal anastomosis and possibly lead to increased stricture rate. As an alternative to an EEA gastrojejunal anastomosis, some groups create an end-side connection with the endo-GIA as described by Champion.[10] Higa et al have described a hand-sewn gastrojejunostomy.[24]

As opposed to the VBG and banding series, the gastric bypass series have significantly larger patients with mean BMIs in the high 40s or low 50s. Some series include patients with BMI $>$ 70 kg/m^2. Operating time generally ranges from two to four hours, and appears to increase with increasing BMI but decreases with experience. Conversion rates are less

Table 8. LAPAROSCOPIC ROUX-EN-Y GASTRIC BYPASS

Author	N	Female (%)	BMI	Mean OR Time (min)	Conversions (%)	Early Comp (%)	Late Comp (%)	Mean Hosp. Stay (d)	Followup (mo)	Weight Loss
Wittgrove	500	NI	NI	120	NI	10.4	2.2	2.6	60	73% @ 54 mo
Higa	400	83	46	NI	3.0	15.0	15.0	1.6*	22	69% @ 12 mo
Schauer	275	81	48	247	1.0	3.3	27.0	2.6	30	77% @ 30 mo
Champion	63	89	50	NI	1.6	3.7	6.3	2.5	12	82% @ 12 mo
Gagner	52	83	55	277	0.0	15.0	3.8	4.0	36	BMI = 34 @ 18 mo

*Excludes stay for conversions; NI = Not indicated clearly in the data.

Table 9. COMPLICATIONS AFTER LAPAROSCOPIC ROUX-EN-Y GASTRIC BYPASS

Author	Leak/ Fistula N (%)	PE N (%)	SBO N (%)	Bleeding N (%)	Stenosis N (%)	Hernia N (%)	MI N (%)	Respiratory Complications N (%)	Mortality N (%)
Wittgrove	11 (2.2)	NI	3 (0.6)	4 (0.8)	8 (1.6)	0 (0)	0 (0)	7 (1.4)	0 (0)
Higa	8 (2.0)	0 (0)	14 (3.5)	2 (0.3)	21 (5.25)	NI	NI	NI	0 (0)
Schauer	4 (1.5)	2 (0.9)	4 (1.5)	9 (3.3)	13 (4.7)	1 (0.7)	0 (0)	16 (5.8)	1 (0.4) 2nd PE
Champion	2 (3.0)	1 (1.5)	1 (1.5)	0 (0)	4 (6.30)	0 (0)	0 (0)	0 (0)	1 (1.5) 2nd PE
Gagner	3 (5.8)	0 (0)	0 (0)	1 (1.9)	NI	2 (3.8)	0 (0)	0 (0)	0 (0)

PE = pulmonary embolism; SBO = small bowel obstruction; EWL = excess weight loss; MI = myocardial infarction; NI = not indicated clearly in the data.

than 5%. Although there appears to be significant variability in methods for detecting and reporting complications, both early and late complication rates (3.3%–15% and 2.2%–27% respectively) are reasonably low. The mean hospital stay (including complications) is typically two to three days. Most series have a mean followup of less than two years but consistently demonstrate a favorable EWL of 65%–80%. Most authors reported that the majority of comorbidities, such as hypertension, sleep apnea, or type 2 diabetes were either resolved or improved with significant weight loss.

Noteworthy specific complications after Lap RYGBP include leaks and bowel obstructions. The larger series report a slightly higher leak rate, particularly at the gastrojejunal anastomosis in their early experience (first 30 cases) that appears to decrease with additional experience. Leaks, however, did not appear to contribute directly to mortality in these series. Most groups reported bowel obstructions related to internal hernias resulting from unclosed mesenteric defects. We advocate, as do others, closure of all potential mesenteric defects at the entero-enterostomy, window through the transverse mesocolon, and between transverse mesocolon and Roux-limb mesentery (Petersen defect). In a series of more than 1,000 cases, Higa et al report the most common complications as stenosis at the gastrojejunostomy (4.9%), internal hernia (2.5%), and marginal ulcer (1.4%) and staple line leaks (1%).[23] The overall mortality in that series was 0.5%.

Our approach to Lap RYGBP at the University of Pittsburgh involves construction of an isolated small gastric pouch (15–30 ml) with a retrocolic, retrogastric Roux-limb (75 cm) and stapled jejunojejunostomy.[55] As advocated by Brolin and others, we extend the Roux-limb length (150–250 cm) for the superobese to achieve greater weight loss in these patients.[7] Our recently published results involved 275 patients who underwent Lap RYGBP with a followup from 3 to 30 months. The median hospital stay was two days and most patients returned to work-related activities within three weeks of surgery. Excess weight loss at 24 and 30 months was 83% and 77%, respectively. In patients with more than one year of followup, most of the comorbidities were improved or resolved. Most notable was the observation that resolution of type 2 diabetes occurred in 82% of patients with the disease, and they no longer required insulin or oral agents. Quality of life, according to the BAROS quality of life instrument, was improved in 95% of patients.

Our current experience exceeds 700 patients with followup up to four years demonstrating similar complications, weight loss, and a conversion rate of 1%. Operating times have decreased to approximately 1.5 to 2 hours for the noncomplex case. Initially, we were quite selective in choosing patients with relatively low body weights (BMI <50) and without prior abdominal surgery. With increased experience, we have performed the operations laparoscopically in patients with significant adhesions and in those with super–morbid obesity (BMI >50).[56, 57] Our current size limit is a BMI in the low 70s. Size limits are primarily dependent on instrument and scope sizes, which are currently inadequate for the massively obese.

The early results of Lap RYGBP compare favorably with most series of open RYGBP (see Table 1). Most notable is the absence or reduced rate of cardiopulmonary, and particularly wound-related, complications. Nguyen et al showed in a randomized trial that Lap RYGBP patients had significantly less pulmonary impairment than did the open-bypass patients on the first three postoperative days.[44] In addition, fewer patients developed hypoxemia requiring supplemental oxygen after Lap RYGBP than after open surgery (31% versus 76%, $p < 0.001$). Only 6% of patients who underwent laparoscopic procedures developed segmental atelectasis on the first postoperative day, compared to 55% of patients in the open group ($p = 0.003$). Significant wound-related complications, including infections and hernias, are virtually nonexistent after laparoscopic gastric bypass. Contemporary data on recovery after open RYGBP are elusive; however a fair estimate is at least 6 to 12 weeks before return to normal activities. The recovery after Lap RYGBP appears to be one-half as long. The mortality rate (0%–1.5%) after Lap RYGBP is comparable to that of the open approach. It has not been demonstrated whether the laparoscopic approach has a positive effect on perioperative mortality in high-risk patients.

The laparoscopic approach, however, certainly entails developmental challenges. The learning curve is very steep and initially requires long operating times. The incidence of intestinal leakage, especially at the gastrojejunal anastomosis, may be higher after the laparoscopic approach than after open RYGBP, at least during the learning curve. Measures such as minimizing tension at the gastric pouch/Roux-limb junction, careful endoscopic examination of the anastomosis, and oversewing of the staple line may reduce leaks. The laparoscopic approach is technically more difficult in the superobese, especially those with a preponderance of abdominal adipose tissue. Our current size limit, a BMI of about 70 kg/m^2, is primarily set because of inadequate instrument length. Finally, the laparoscopic approach may be exceedingly difficult in patients with enlarged livers because of inadequate exposure of the esophagogastric junction. Additional ports to retract the enlarged liver may be necessary.

Technique of Laparoscopic Roux-en-Y Gastric Bypass

The patient is placed supine in steep reverse Trendelenburg position with surgeon on the right and assistant on the left and two monitors placed above the patient's shoulders.[55] After creation of carbon dioxide pneumoperitoneum (15 mmHg) using the Veress needle technique, cannulas (US Surgical, Norwalk, CT) are placed as shown in Fig. 4A. To expose the esophagus and stomach, a 5-mm liver retractor (Snowden Pencer) is placed through the inferior right subcostal port, and the left lateral segment of the liver is elevated. Gastric pouch creation is per-

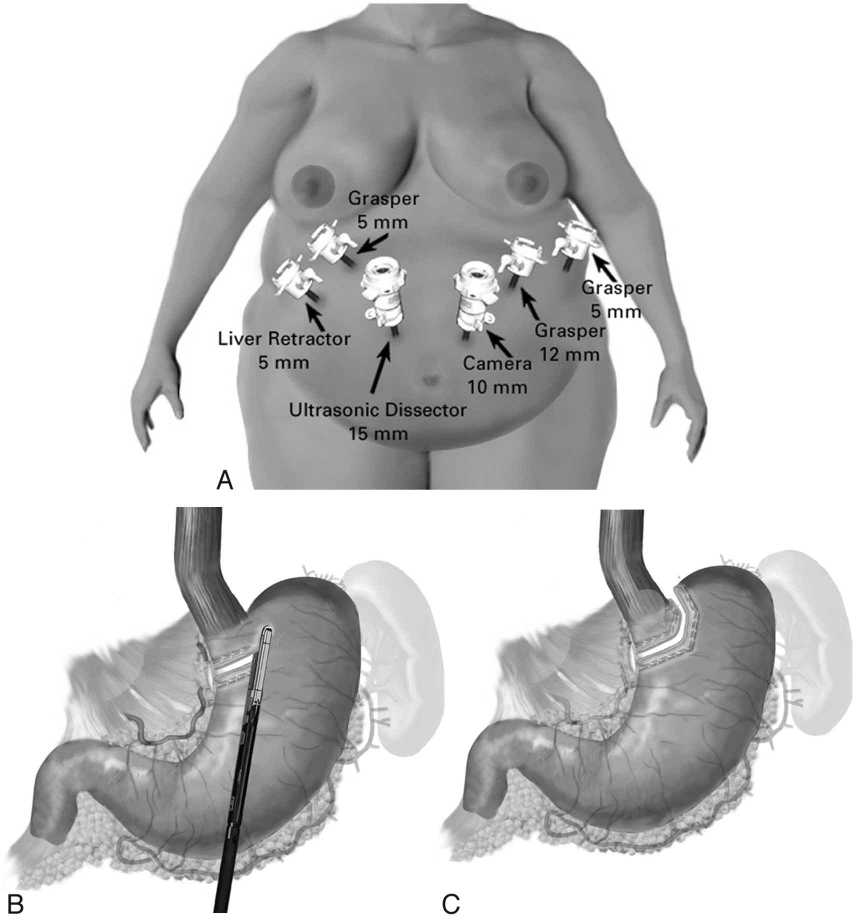

Figure 4. Laparoscopic gastric bypass. *A*, Set-up and port placement for laparoscopic Roux-en-Y gastric bypass. *B and C*, Gastric pouch creation.

Illustration continued on opposite page

formed as shown in Fig. 4B. To localize the esophagogastric junction and size the pouch, a Baker jejunostomy tube can be inserted orally into the stomach, inflated with saline to 15 ml, and drawn up to the cardia. After withdrawing the balloon, the surgeon creates a window in the lesser omentum near the gastric wall at the lesser curvature. The endo-GIA stapler (US Surgical), 60 mm long with 4.8-mm staples, is inserted and applied three times to staple and cut the gastric pouch with three rows of staples on each side.

The patient is returned to the supine position to create the retrogastric-retrocolic tunnel for the Roux-limb (Fig 4C). The greater omentum

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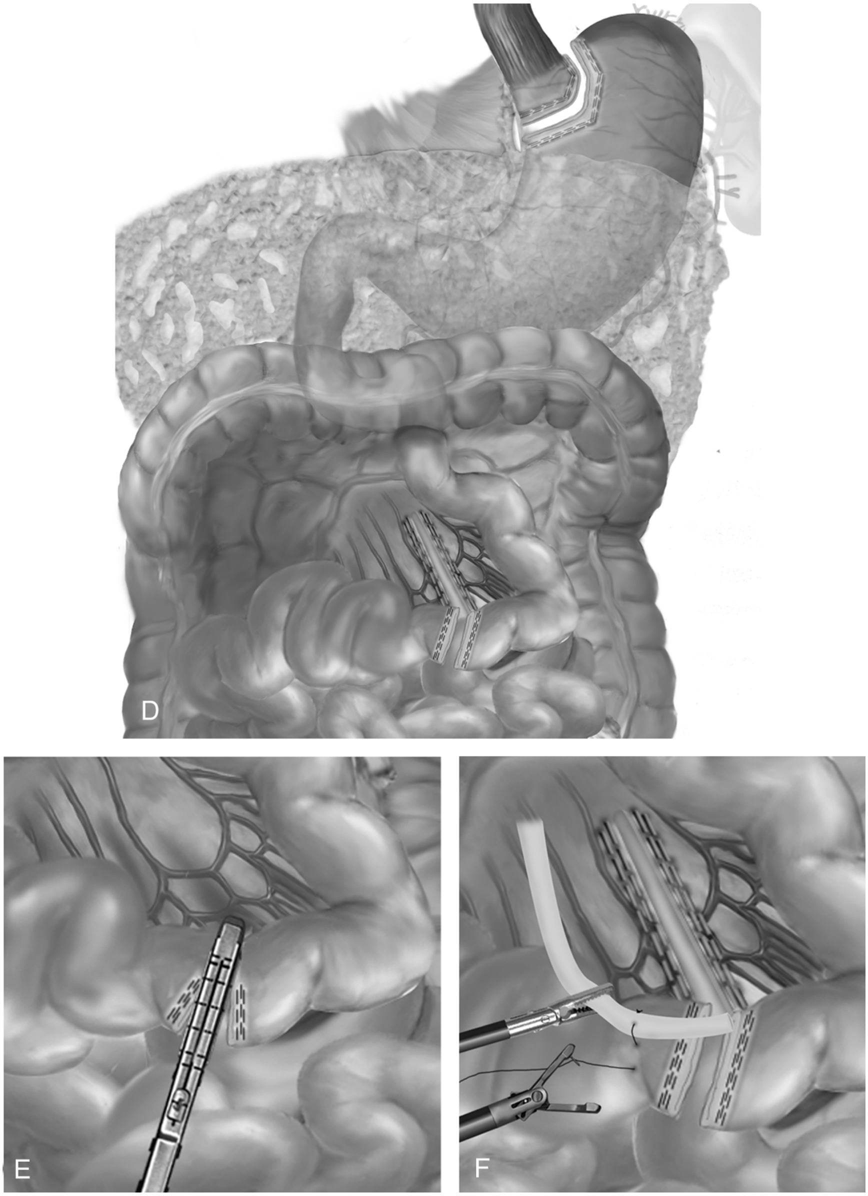

Figure 4 *(Continued). D–F*, Roux-limb creation—division of jejunum.
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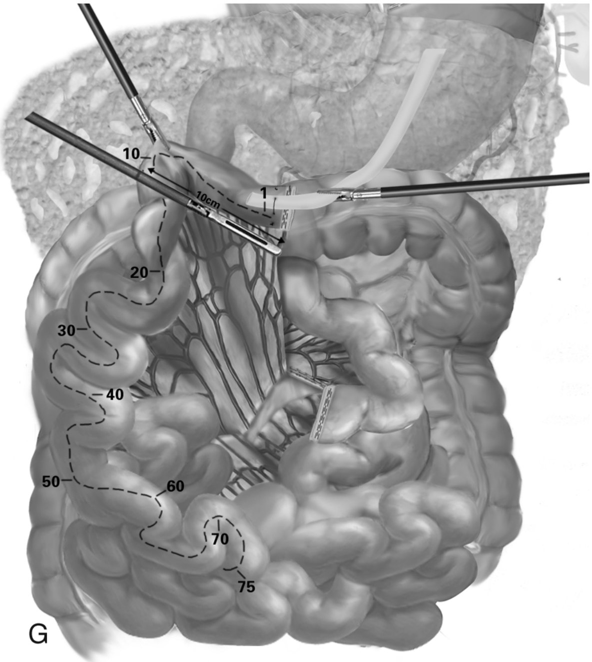

Figure 4 *(Continued). G*, Measurement of Roux-limb.
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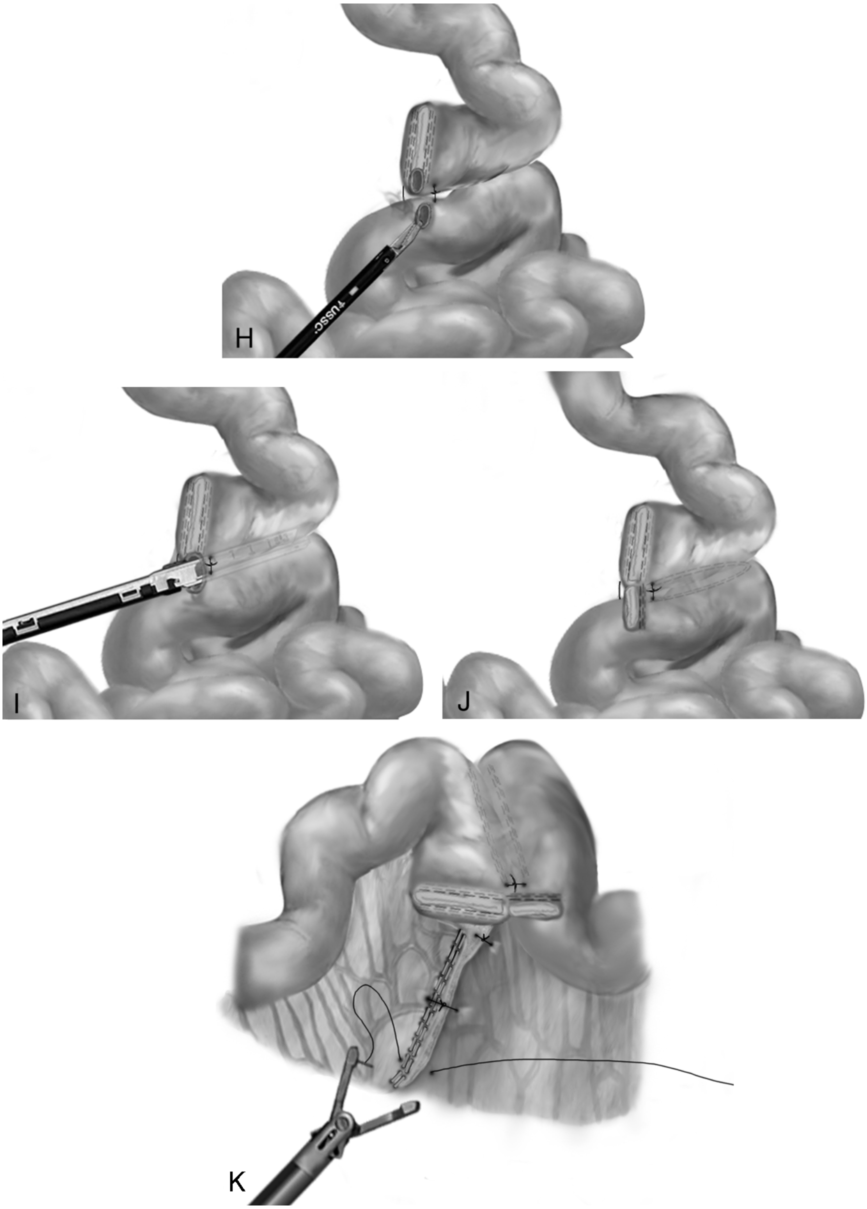

Figure 4 *(Continued). H–K*, Steps 1–4 of the creation of entero-enterostomy.

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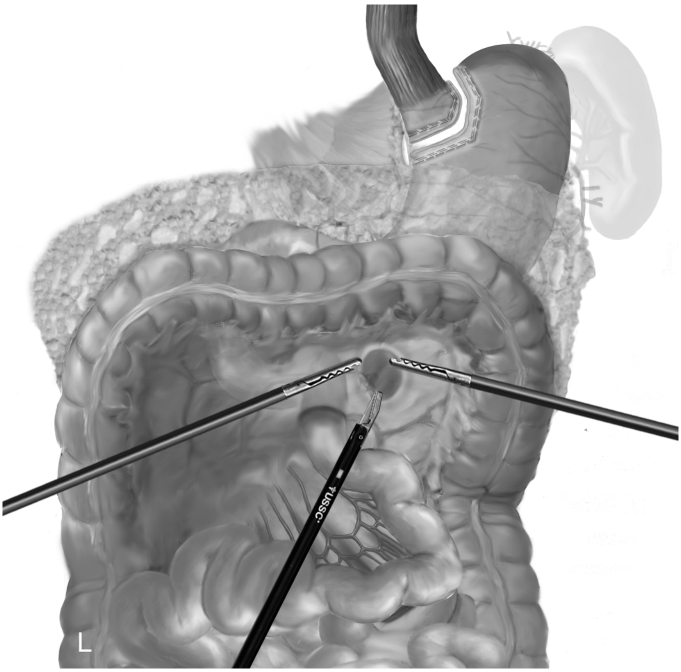

Figure 4 *(Continued). L*, Creation of window in transverse mesocolon.
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Figure 4 *(Continued). M*, Passage of Roux-limb.
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and transverse colon are passed to the upper abdomen to expose the mesentery of the transverse colon near the ligament of Treitz.

To create the Roux-limb, the jejunum is transected with an Endo-GIA II stapler (US Surgical), 45 mm long and 3.5-mm staples, approximately 30 cm from the ligament of Treitz where a comfortable length of mesentery exists (Fig 4D, E). The jejunal mesentery is then divided with two applications of the Endo-GIA II stapler using the vascular load (45 mm long, 2.0 mm staples). A 6-cm length of Penrose drain is sewn to the end of the Roux-limb using the Endostich (US Surgical Corp) (Fig. 4F). The Roux-limb is then measured 75 cm distally (Fig. 4G) and a stapled side-side anastomosis is created (Fig. 4H, I, J) with the proximal jejunal limb using the Endo-GIA stapler II, 60 mm long, 3.5-mm staples. The enterotomy sites are stapled closed. The mesenteric defect is closed (Fig. 4K). Roux-limb length can be extended as desired. Using ultrasonic dissection, a window is created in the mesocolon immediately anterior

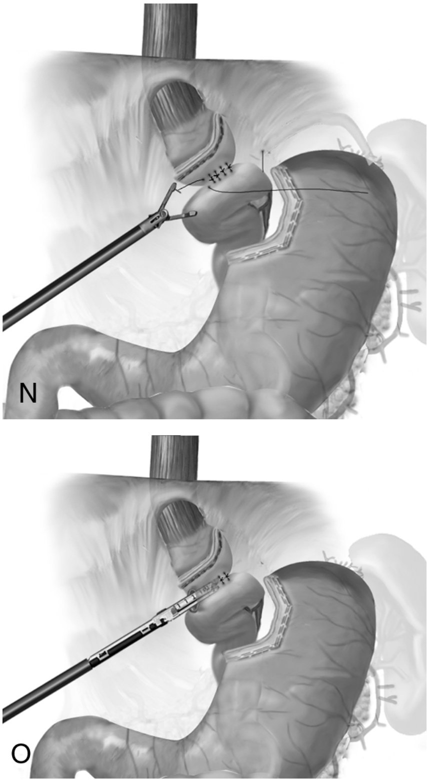

Figure 4 *(Continued). N–Q*, Steps 1–4 of end-side gastrojejunostomy. *R*, Completed operation.

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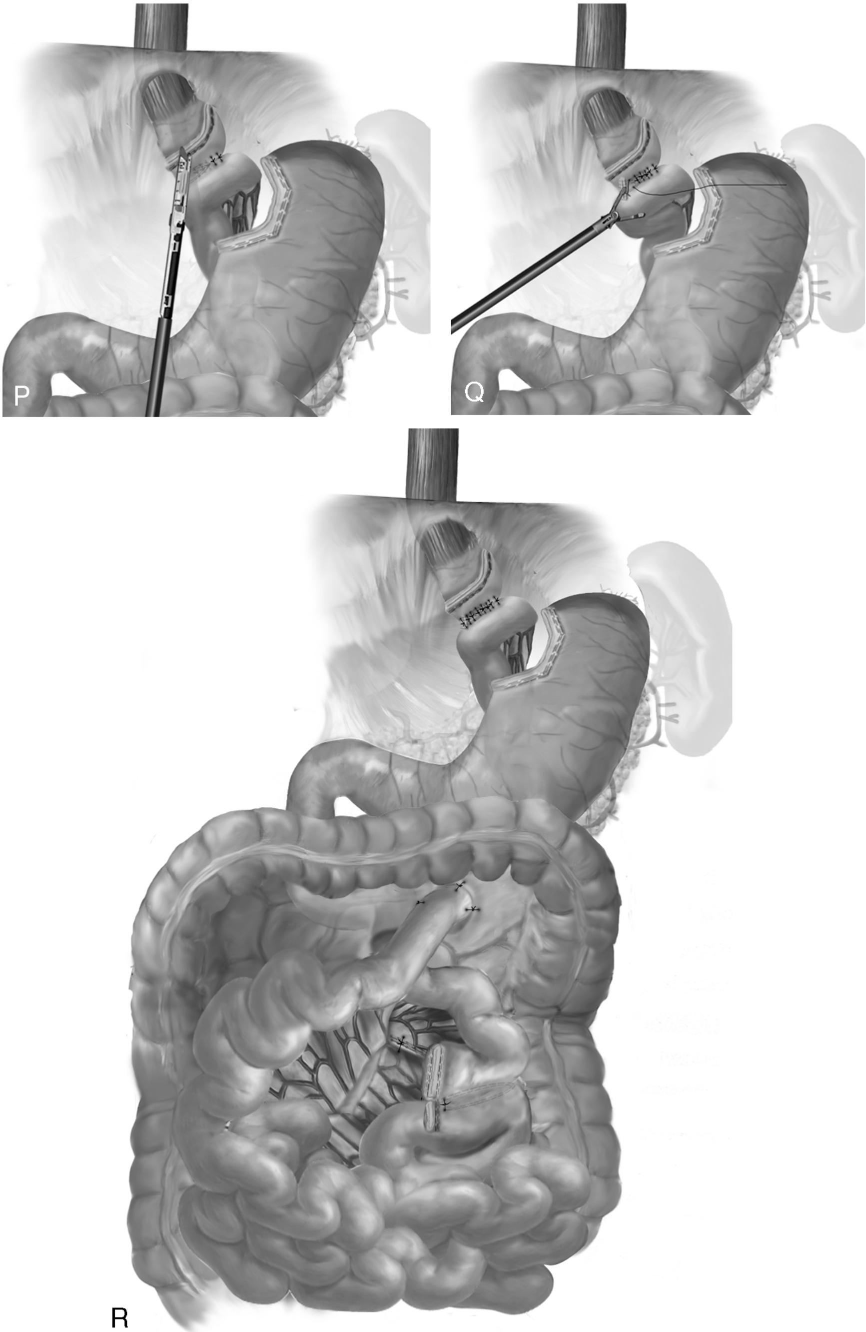

Figure 4 *(Continued).*

and lateral to the ligament of Treitz to gain access to the lesser peritoneal sac.

The gastrojejunostomy can be created using a circular or linear stapling technique or it can be hand-sewn. We prefer a two-layer closure utilizing the Endo GIA stapler as shown in Figures 4M–4Q. First, the Roux-limb is passed through the retro-colic, retro-gastric tunnel up towards the gastric pouch (see Fig. 4M). Then, sutures (2-0 Surgidac, US Surgical Corp) are placed (interrupted or running) to approximate the posterior pouch wall with the end of the Roux-limb (see Fig. 4N). The Endo GIA stapler (3.5mm staples) is then inserted through enterotomies into the pouch and jejunum to create the end-side anastomosis (see Fig. 4O). The remaining enterotomy is closed using the Endo GIA stapler or running suture (not shown) with a bougie or endoscope (12-14mm diameter) used as a stent (see Fig. 4P). A final anterior layer of interrupted or running suture (2-0 Surgidac) is placed (see Fig. 4Q), to complete the anastomosis. The gastrojejunostomy is endoscopically tested for leakage after insufflating and submerging it in irrigation fluid. A drain is placed posterior to the anastomosis. The mesenteric defect in the transverse mesocolon is closed with sutures to complete the operation (see Fig. 4R). A nasogastric tube is rarely used.

LAPAROSCOPIC MALABSORPTION PROCEDURES

Laparoscopic approaches to malabsorption procedures, such as the biliopancreatic diversion operation developed by Scopinaro and the duodenal switch operation advocated by Marceau, are currently being developed.[35, 63] They are considerably more complex and technically difficult than the previously described operations. At least in North America, the role of malabsorption procedures in the treatment of morbid obesity is limited; they comprise less than 15% of bariatric operations. Although they are effective weight-loss operations, these procedures remain controversial because of the relatively high risks of nutritional complications such as protein malnutrition and severe vitamin deficiencies. The relative value of laparoscopic malabsorption procedures in terms of reduced perioperative morbidity should be weighed against the significant long-term consequences of malabsorption. Nevertheless, these procedures may have a role in treating patients known to be refractory to gastric bypass, such as the extremely obese (BMI $>$ 70) or patients who have failed gastric bypass.

Ren et al have published the only study to date that evaluates early results of a laparoscopic malabsorption procedure.[50] They performed a laparoscopic approach to biliopancreatic diversion with duodenal switch (BPD-DS) in 40 patients with a mean BMI of 60 k/m^2. The operation involved a 150- to 200-ml sleeve gastrectomy with the remaining stomach anastomosed to the distal 250 cm of divided ileum, leaving a common channel of 100 cm. The conversion rate was 2.5% with a mean operating time of 210 min and hospital stay of four days. Major morbidities occurred in 15% and mortality was 2.5%. Median followup at nine months showed a 58% excess weight loss (EWL). This study showed that laparoscopic BPD-DS is feasible with a reasonable perioperative morbidity and mortality. Whether it offers significant advantages over other open or laparoscopic procedures remains to be shown.

HAND-ASSISTED LAPAROSCOPIC BARIATRIC SURGERY

Because of the formidable technical challenges of laparoscopic approaches to bariatric operations, hand-assisted modifications are emerging to facilitate these operations. Hand-assisted approaches involve using devices that allow the surgeon to insert one hand intra-abdominally through a small access incision (6–8 cm) to assist with the laparoscopic procedure (Fig. 5).[39] These devices form an airtight seal around the surgeon's arm to prevent pneumoperitoneum leakage. In concept, hand-assisted laparoscopy is a hybrid of open surgery and laparoscopy, an attempt to maximize the benefits of both approaches.

Although VBG and RYGBP have been performed with hand-assisted techniques, experience is limited.[42, 74] Bleier et al[5] showed faster recovery after hand-assisted VBG compared to that of open VBG in 46 patients, but had a relatively high staple-line leak rate of 6.5% in the hand-assisted group. Schweitzer et al reported their initial experience in eight patients (mean BMI 44kg/m^2) undergoing hand-assisted RYGBP with a 7.5-cm periumbilical incision and operating times of 2.25 to 4.5 hours.[62] They concluded that the hand-assisted approach significantly simplified

Figure 5. Hand-assisted bariatric surgery. Pneumosleeve (Dexterity, Inc., Blue Bell, PA).

the procedure compared to that of a completely laparoscopic approach. The value of a hand-assisted bariatric approach may be that it is a useful adjunct to facilitate the learning curve of the completely laparoscopic procedure. The potential enabling capability of hand-assisted bariatric surgery must be weighed against the ill effects of a hand-access incision, which for some surgeons can be quite significant. Other than for routine use, hand-assisted techniques may be an alternative for patients who may not be candidates for a completely laparoscopic approach, e.g., the massively obese (BMI > 60 kg/m^2), patients with extensive adhesions or massive livers, or patients undergoing reoperative surgery.

TRAINING ISSUES FOR LAPAROSCOPIC BARIATRIC OPERATIONS

Laparoscopic bariatric surgery, particularly Lap RYGBP, is technically challenging because it requires skills not required for many advanced laparoscopic procedures. Both obesity-related factors and the complexity of these reconstructive procedures create the major technical barriers. Table 10 summarizes some of the technical challenges of Lap RYGBP. Lap RYGBP remains one of the most difficult advanced laparoscopic procedures currently performed today. Table 11 lists the relative degree of difficulty of some major laparoscopic procedures according to the author's experience. Thus, patient factors such as massive obesity (BMI > 60 kg/m^2), severe hepatomegaly, prior abdominal surgery, and reoperative bariatric surgery may increase the degree of difficulty by several magnitudes. This high degree of difficulty translates into a steep

Table 10. TECHNICAL CHALLENGES OF LAP RYGBP

- Excessive abdominal adiposity
  - Extra-abdominal fat
    - Insufficient trocar length
    - Insufficient scope and instrument length
    - Limited freedom of movement
    - Air leaks
  - Intra-abdominal fat
    - Viscera obscured by fat
    - Exposure/retraction challenges
    - Fatty viscera, especially liver
- Severe obesity and high comorbidity
  - ASA III or greater
  - Significant cardiopulmonary disease
  - Decreased tolerance of CO_2 pneumoperitoneum
  - Difficult airway requiring advanced intubation techniques
- Operating in multiple abdominal compartments
- Advanced intracorporal stapling techniques
- Advanced suturing techniques
- Advanced hemostasis techniques
- Advanced flexible endoscopy

Table 11. LAPAROSCOPIC OPERATIONS DEGREE OF DIFFICULTY SCALE (1 TO 10, 10 MOST DIFFICULT)

Lap cholecystectomy	3.0
Lap appendectomy	3.0
Lap hernia	4.0
Lap nissen	6.0
Lap splenectomy	7.0
Lap adrenalectomy	7.0
Lap colectomy	8.0
Lap esophagectomy	9.5
Lap gastric bypass	9.5

learning curve and a potentially higher rate of perioperative technical complications, such as intestinal perforation, anastomotic leaks, bleeding, bowel obstruction (failure to adequately close mesenteric defects), and inadvertent visceral injury. Other undesirable consequences attributed to the complexity of this operation include a longer operating time (at least initially) and a potentially higher conversion rate. Acquisition of advanced laparoscopic skills is essential for safe and effective performance of laparoscopic bariatric operations. Surgeons who do not have the benefit of experience with at least some of the other advanced laparoscopic procedures will be at a significant disadvantage. Either fellowship training or extended mentoring by an experienced surgeon is an optimal method of obtaining the necessary skills and experience.

It is critical that surgeons interested in performing laparoscopic bariatric operations, especially Lap RYGBP, prepare for these advanced procedures. Guidelines for performing laparoscopic and open bariatric surgery have been recently established by major surgical societies such as the American College of Surgeons, Society of American Gastrointestinal Endoscopic Surgeons (SAGES), and the American Society of Bariatric Surgery.[8, 51] Short, introductory courses with didactic presentations, hands-on experience, and live demonstrations can be very helpful, but they are the beginning, not the end, of preparation. The surgeon first must be familiar with and preferably trained in the management of the bariatric patient, including appropriate indications for surgery, preoperative evaluation, perioperative management, and long-term followup care. Operative experience with open bariatric operations is extremely valuable and optimal. Advanced laparoscopic skills must be mastered, and experience with advanced laparoscopic foregut surgery and endoscopy is essential. Animal laboratory experience and proctoring by an experienced surgeon are highly recommended. Fundamentals of both bariatric surgery and advanced laparoscopic surgery should be mastered before performing Lap RYGBP.

SUMMARY

Minimally invasive approaches to bariatric surgery offer significant advantages over those of open surgery. The potential of laparoscopic

approaches to reduce the morbidity of these operations may exceed that of laparoscopic cholecystecomy and laparoscopic Nissen fundoplication because the access incisions for open bariatric operations have relatively greater potential for harming the morbidly obese patient. Early results of laparoscopic VBG suggest a significant decrease in perioperative morbidity compared to the open approach, with similar weight-loss results. LGB may have the lowest perioperative morbidity and mortality of all current bariatric operations. However, the reoperation rate for device-related complications or failure of the patient to lose sufficient weight appears significant. Long-term esophageal motility also remains questionable for the LGB. It is hoped that the FDA trial will address many of the issues regarding LGB. Results of Lap RYGBP are accumulating and appear promising. The early experience suggests that it is technically feasible and safe in the hands of surgeons who have appropriate training. It is associated with low perioperative morbidity, short hospital stay, and rapid recovery compared to expected results of open RYGBP. Weight loss for Lap RYGBP after 5 years is excellent. It is, however, a technically formidable operation requiring long operating times and a steep learning curve. Early results indicate that technical complications may be greater than those experienced with open RYGBP because of the learning curve. Lap RYGBP is a promising bariatric procedure with potentially significant advantages over open RYGBP. Thus, for patients in the United States, Lap RYGBP may become the preferred weight-reduction procedure. The value of hand-assisted bariatric procedures and laparoscopic malabsorption procedures must await further study.

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Address reprint requests to

Philip R. Schauer, MD
Presbyterian University Hospital, C–800
200 Lothrop Street
Pittsburgh, PA 15213–2582

e-mail: schauerpr@msx.upmc.edu