The Duodenal Switch Operation for the Treatment of Morbid Obesity: A 10 Year Experience

Gary J. Anthone, Reginald V. N. Lord, Tom R. DeMeester, Peter F. Crookes.

From the Department of Surgery, University of Southern California Keck School of Medicine, Los Angeles CA. 90033.

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Correspondence to Dr Anthone, Director, USC Bariatric Surgery Program, 1450 San Pablo Street, Suite 5501, Los Angeles, CA. 90033-4612. Tel: 323 442 6219 Fax: 323 442 6280 Email: ganthone@surgery.usc.edu

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SHORT RUNNING HEAD: Duodenal switch operation for morbid obesity.

MINI-ABSTRACT

The longitudinal gastrectomy with duodenal switch operation was performed as the primary treatment for morbid obesity in 701 patients. The mean loss of excess body weight exceeded 65% at five or more years. Perioperative mortality was 1.4% and morbidity was 2.9%. The procedure is a safe and effective treatment for morbid obesity.

ABSTRACT

Objective To determine the safety and efficacy of the duodenal switch procedure as surgical treatment for morbid obesity.

Summary Background Data The longitudinal gastrectomy and duodenal switch procedure as performed for morbid obesity involves a 75% subtotal greater curvature gastrectomy and long limb suprapapillary Roux-en-Y duodenoenterostomy. This results in a restricted caloric intake and diversion of bile and pancreatic secretions to induce fat malabsorption. Broad acceptance of this procedure has been impeded because of concerns that the malabsorptive component may produce serious nutritional complications.

Methods Review of data collected prospectively from all patients who underwent duodenal switch as the primary surgical treatment for morbid obesity at a single institution during the ten year period beginning September 1992. Operative morbidity

and mortality, weight loss, volume of food intake, and bowel function were recorded. Sequential measurements of serum albumin, hemoglobin, and calcium levels were obtained to assess metabolic function and nutrient absorption.

Results Duodenal switch was performed as the primary operation in 701 (81%) of a total 863 patients undergoing bariatric surgery during the period of study. The average BMI was 52.8 (range 34-95). Perioperative mortality was 1.4% and morbidity (including leaks, wound dehiscence, splenectomy, and postoperative hemorrhage) occurred in 21 patients (2.9%). Weight loss averaged 127 pounds at one year, 131 at three years and 118 at five or more years (% EBWL of 69%, 73%, and 66%, respectively). The mean number of bowel movements was less than three per day. Patients reported and maintained a mean restriction of 63% of their preoperative intake (approximately 1600 calories), with no specific food intolerance, at 3 or more years follow-up. At three years, serum albumin remained at normal levels in 98% of patients, hemoglobin in 52%, and calcium in 71%. No patients reported dumping and marginal ulcers were not seen.

Conclusions The longitudinal gastrectomy with duodenal switch is a safe and effective primary procedure for the treatment of morbid obesity. It has the advantage of allowing acceptable alimentation with a minimum of side effects while producing and maintaining significant weight loss. These results are achieved without developing significant dietary restrictions or clinical metabolic or nutritional complications.

INTRODUCTION

Morbid obesity is defined as having a body mass index (BMI) of greater than 40 kg/m^2 or being 100 lbs over ideal body weight as defined by the 1983 Metropolitan Life Insurance tables.[1] Although environmental factors are clearly important, identical twin studies[2] and ongoing elucidation of the functional roles of hormones such as leptin[3,4] and ghrelin[5] have shown that genetic and physiologic factors have a major role in the etiology of this disease. In the United States, morbid obesity has reached epidemic proportions. Two percent of the adult male and 6% of the adult female population, a total of approximately 12 million Americans, are morbidly obese. The disease is associated with an increased risk of serious co-morbidities including type II diabetes, sleep apnea, cardiovascular diseases, and orthopedic disabilities. It has recently been estimated that individuals with morbid obesity have a mortality risk similar to that of smokers.[6] A 25 year old male with a body mass index of 45 can expect to lose approximately 14 years of life.[7]

Non-operative treatments for patients with morbid obesity have not been shown to produce reliable long-term benefit, consequently surgical therapy has become the preferred treatment.[8] It is estimated that 98,000 surgical procedures for the treatment of obesity will be performed in 2003, compared with 63,000 in 2002 and 47,000 in 2001.[9] The 1991 National Institutes of Health consensus conference on morbid obesity recommended that surgery be considered for well-informed patients with acceptable operative risks.[10] The intention of the conference, although often construed to be otherwise, was not to recommend or condemn a particular surgical procedure.

Historically, the first surgical procedure designed to produce weight loss was the jejunoileal bypass in 1953.[11] The severe hepatic, metabolic, and nutritional complications of this procedure[12] led to the development of the loop gastric bypass,[13] the vertical banded gastroplasty,[14] and the Roux-en-Y gastric bypass.[15] In 1979, Scopinaro described the biliopancreatic diversion procedure combining a distal gastrectomy with a long limb Roux-en-Y reconstruction to induce fat malabsorption.[16]

The duodenal switch procedure was described by DeMeester in 1987 as a surgical solution for primary bile reflux gastritis or to decrease the post-gastrectomy symptoms seen in patients after distal gastrectomy and gastroduodenostomy.[17] Hess, later that year, adapted this procedure to the treatment of morbid obesity by adding a 75% longitudinal gastrectomy to reduce gastric capacity and acid production and extending the Roux limb to a length similar to that recommended by Scopinaro to induce fat malabsorption (**Figure 1**).[18] Despite favorable reports on the use of the duodenal switch procedure for the treatment of morbid obesity,[18-23] it has been slow to gain widespread popularity. There are three reasons for this. First, there is a perception that its malabsorptive component may be associated with metabolic complications, protein calorie malnutrition, or other nutrient deficiencies, second, the procedure is longer and more technically demanding than other bariatric operations, and third, the procedure is difficult to perform laparoscopically. The aim of the current study is to report the results obtained over a ten year period on the use of the duodenal switch procedure for the treatment of morbid obesity at a single institution, with a specific focus on its safety and efficacy.

METHODS

The study population consisted of 701 patients who underwent a duodenal switch operation for weight loss at the University of Southern California during the 10 year period beginning September 1992. Patients who had prior weight loss surgeries or underwent another type of bariatric operation were excluded (N = 162). All patients were informed about the various surgical procedures for weight loss at an educational seminar prior to their individual evaluation in the clinic. Preoperative testing included pulmonary function studies with room air arterial blood gas analysis, a cardiac stress evaluation, a barium upper gastrointestinal contrast study, ultrasound of the liver and gallbladder, and serum hematologic and chemical metabolic profile. Psychological assessment was mandatory. Prior to obtaining informed consent, patients were given a multiple choice examination to test their understanding of weight loss surgery in general and the duodenal switch operation in particular.

The majority of patients were admitted on the day of surgery. An epidural catheter was placed preoperatively for postoperative pain management. Central venous and arterial lines, a Foley catheter, sequential compression stockings, and special operating table padding precautions were used routinely. The surgery was performed via an upper midline incision using the Gomez retractor (Pilling Surgical, Horsham, PA.). The triangular ligament of the left lateral liver segment was incised to expose the area of the hiatus. After ligating all gastroepiploic and short gastric vessels, a 75% longitudinal gastrectomy was performed leaving a tubularized stomach of approximately 100 cc

(**Figure 2**). The duodenum was divided proximal to the ampulla, about 4 cm beyond the pylorus at the level of the gastroduodenal artery. The small bowel length was measured using a 15 cm umbilical tape placed sequentially along the unstretched antimesenteric border. The small bowel was divided at its mid point and the distal end (alimentary limb) was brought through a window created in the transverse mesocolon and anastomosed to the proximal duodenum (**Figure 3**). The proximal end of the divided small bowel, now the distal end of the biliopancreatic limb, was anastomosed to the ileum 100cm from the ileocecal valve to create a 100 cm common channel (Figure 1). A cholecystectomy and feeding jejunostomy were performed. On postoperative day three, a video swallow was performed to exclude anastomotic stenosis and if normal a clear liquid diet was started. Most patients were taking a solid diet at the time of their discharge on the fifth postoperative day.

Postoperatively, patients were seen initially at 3 and 6 weeks, at then every three months during the first year, 18 and 24 months during the second year, and yearly thereafter. At each visit the patients were weighed, the volume of food and calories ingested was estimated using a questionnaire and a dietician interview, and the number of daily bowel movements were recorded. The serum albumin, hemoglobin, and calcium were measured. Patients were repeatedly instructed to take daily vitamin and mineral supplementation.

The Student's t-test was used for all continuous demographic and follow-up data. The paired t-test was used for preoperative and sequential follow-up data analysis within the same groups of patients. The Mann-Whitney U test was used to test for associations

between continuous factors and the outcome perioperative mortality. Fisher's exact test was used to compare proportions between two groups. All P values are 2-sided. SPSS version 11.5 software (SPSS Inc., Chicago Ill.) was used for all statistical analyses.

RESULTS

Demographic details.

Demographic data for the total 701 patients who underwent the duodenal switch procedure for weight loss, and for males and females separately, are shown in **Table 1**. The preoperative weight, excess body weight (EBW), and BMI were all significantly higher in males. Fifty-eight percent of the patients (407) were supermorbidly obese, with a BMI equal to or greater than 50 kg/m^2. Twenty two percent of the patients (155) had a preoperative BMI greater than or equal to 60 kg/m^2.

Accrual of patients increased progressively over the ten year period, with most patients (66%) operated on during the last three years (**Figure 4**).

Weight loss.

Figure 5 shows the mean and 95% confidence intervals for percent excess body weight loss (%EBWL) for all patients at 6, 12, 36, and $\geq$ 60 months after operation. **Table 2** shows the mean and median for weight loss, %EBWL, and BMI for the total study population. Patient weight and body mass index were significantly lower, and the %EBWL was significantly higher, at all postoperative intervals compared to the preoperative values (all $P<0.001$, all paired samples t-test).

The %EBWL for males and females was similar (**Figure 6**). Patients with a preoperative BMI $\geq$ 50 kg/m^2 had a slightly lower %EBWL at all postoperative intervals compared to patients with a preoperative BMI <50 kg/m2, but this difference was not statistically significant after the first postoperative year (**Figure 7**). **Table 3** shows the mean weight loss, the BMI, and the %EBWL for patients with a preoperative BMI <50 kg/m^2 and $\geq$ 50 kg/m^2. The success rate of the procedure, using the criteria of a loss of at least 50% of excess body weight (%EBWL$\geq$50) for the total patients and those with a preoperative BMI < and $\geq$ 50 kg/m^2, is shown in **Figure 8**. Even in superobese patients (preoperative BMI $\geq$ 50 kg/m^2), the success rate was 78.6% and 73.3% at 3 and 5 or more years, respectively.

Nutritional and Metabolic Parameters, Dietary Volume, and Bowel Function

Maximum weight loss occurred by three years after operation and represents the time of maximal metabolic and nutritional challenge. At this time interval, the percentage of patients with normal serum values was 98.3% for albumin (normal range 3.2-5.0 g/dL), 70.7% for total calcium (normal range 8.5-10.3 mg/dL), and 51.7% for hemoglobin (normal range: 13.8-17.2 g/dL (males), 12.0-15.6 (females) (**Table 4**). Apart from the 40 patients who required readjustment of the length of the common channel, no clinical sequelae have occurred from hypocalcemia or anemia. Of importance, there was no clinical evidence of hepatic dysfunction.

Table 5 shows (1) the patients' assessment of ingested volume as a percentage of their preoperative volume, (2) the dietician's estimate of daily caloric intake, and (3) the mean number of bowel movements per day. Despite a gradual increase in dietary volume and caloric intake, weight loss was maintained, indicating that the malabsorptive component of the procedure is effective. The observation that the mean caloric intake was limited to less than 1700 calories per day indicates that the restrictive component was working as well. These benefits were achieved with minimal to no restrictions on the types of food ingested. Bowel habits were minimally altered despite a 100 cm common channel. Dumping did not occur, indicating that, in addition to preservation of the pylorus, vagal control of gastrointestinal function was maintained.

Morbidity and Mortality

Perioperative (in hospital and 30 day postoperative) deaths occurred in ten of the 701 (1.4%) patients. The causes of death were pulmonary embolus in four patients, rhabdomyolysis in two, duodenal stump leak in one, gastric leak in one, cecal necrosis in one, and aspiration pneumonia in one. Demographic data for the ten patients who died are shown in **Table 6.** Male gender, older age, and higher preoperative BMI were significantly associated with perioperative mortality.

Significant perioperative morbidity occurred in 21 patients (2.9%). Non-fatal leaks occurred at the duodenoenteric anastomosis in one patient, at the enteroenterostomy anastomosis in one, duodenal stump in one, and at the gastric staple line in two.

Splenectomy to control bleeding was necessary in three patients. Four patients required postoperative exploratory laparotomy: two for bleeding, one for small bowel obstruction, and one for presumed abdominal sepsis. Four out of six patients recovered from gluteal rhabdomyolysis. Wound dehiscence occurred in five patients.

Revisional surgery to increase the length of the common channel was necessary in 40 patients (5.7%). Reoperation was driven by evidence of malnutrition reflected in hypoalbuminemia, peripheral edema, or continued weight loss (34 patients); by persistent diarrhea despite a restriction of fat intake and medication use (four patients); or by chronic unexplained abdominal pain (two patients).

DISCUSSION

The cardinal finding of this study is that the duodenal switch is a safe and effective primary operation for the treatment of morbid obesity. The safety of the procedure is evident by the low operative mortality comparable to other large series,[24,25], and satisfactory weight loss without significant side effects. Similar to Livingston et al., we found that male gender, age, and superobesity are all significant risk factors for mortality. Several large studies of both open and laparoscopic bariatric surgery have reported lower mortality rates, but these series included a lower proportion of superobese patients (BMI > 50 kg/m^2; 58% of patients in our series). The morbidity of the duodenal switch procedure is also similar to reports on the open gastric bypass series.[24,25] Of interest is the observation that our anastomotic leak rate is low compared to other reports. This is likely due to the close proximity of the bowel and thus the lack of tension on the duodenoenteric anastomosis compared to the gastroenteric anastomosis performed near the cardia in the standard gastric bypass procedure. The risk of leakage from the longer longitudinal gastric suture line is minimal and is comparable to the leak rate from the gastric staple line in the gastric bypass procedure.

The duodenal switch operation includes both a restrictive and a malabsorptive component. This has resulted in conflicting opinions regarding the side effects of the malabsorptive component, with some investigators believing that severe metabolic and nutritional complications are frequent after the operation. This is likely due to a presumed similarity of the currently performed malabsorptive operations i.e. biliopancreatic bypass

and duodenal switch, to the old and now-discredited jejunoileal bypass. Unlike the jejunoileal bypass, the duodenal switch does not have a blind enteric limb. Rather, both limbs are stimulated, one with food and the other with biliopancreatic secretions, thus preventing mucosal atrophy, bacterial overgrowth, and liver injury. Indeed, we have not seen instances of liver failure following the duodenal switch operation. We recently reported the results of the duodenal switch procedure on liver histology by studying biopsy specimens before and after weight loss.[26] An activity score, based on lobular inflammation or necrosis, fatty change, and other factors, and a portal fibrosis score, were both decreased or unchanged in most patients.

A modification of gastric bypass, by lengthening the Roux limb, has been proposed for patients with more extreme degrees of obesity or when the routine Roux-en-Y bypass has failed. This "Long-Limb" or distal gastric bypass has been associated with significant metabolic and nutritional complications that have been inappropriately assumed to occur with the duodenal switch procedure.[27-29] The hypoalbuminemia and other nutritional deficits observed in patients with a long limb gastric bypass may be secondary to the combination of extreme gastric restriction imposed by the procedure along with a malabsorption component. In contrast, the duodenal switch procedure allowed patients to ingest approximately two thirds of their preoperative dietary volume without specific food intolerances, and more than 98% had a serum albumin within the normal range three years after surgery.

A certain percentage of patients will develop anemia and hypocalcemia after any operation which bypasses the duodenum, including Roux-en-Y gastric bypass and the duodenal switch. This is because iron and calcium are preferentially absorbed in the distal duodenum and proximal jejunum. The frequency of anemia in our study was 48% and is comparable to that reported by Brolin et al. after Roux-en-Y gastric bypass, where it varied from 41% after a short limb to 74% after a long Roux limb.[29] After duodenal switch procedure, the degree of anemia was usually mild but in a small percentage of patients it proved refractory to oral iron supplementation, even though a portion of duodenum remains. These patients do respond to parenteral iron injections. Further, we have not observed Vitamin B12 deficiencies, in contrast to the 35% incidence reported after Roux-en-Y gastric bypass.[29] This is likely due to the preservation of more gastric mucosa with the duodenal switch procedure.

We recently reported the effect of the duodenal switch operation on calcium and parathyroid hormone metabolism (presented at Pacific Coast Surgery Association, February 2003). No patient has developed clinical evidence of hypocalcemia or bone loss, a finding consistent with other reports of calcium metabolism following the duodenal switch procedure.[30]

The magnitude of weight loss that occurs after the duodenal switch procedure is comparable to that achieved by Roux-en-Y gastric bypass procedure. Criteria for satisfactory weight loss are not well defined in the literature, but loss of 50% of EBWL is broadly accepted as a measure of success. It is notable that in the study by MacLean et al.

on isolated gastric bypass, only 57% of patients with super-morbid obesity (BMI> 50) achieve this goal.[31] In contrast, 73.3% of patients with BMI≥ 50 achieved success by this criterion at five or more years after duodenal switch operation in the present study, with even higher success rates reported by Hess et al.[18]

If the mortality and morbidity of the duodenal switch is comparable to other common weight loss procedures, what advantage does it have to offset the longer operative time and technical difficulty? In our view the answer relates to quality of life. While it is unquestioned that morbidly obese patients must adopt some behavioral change of their eating habits, most bariatric procedures which employ a small proximal gastric pouch and Roux-en-Y limb are characterized by a much more extreme restriction of intake and the development of the dumping syndrome. Indeed it is commonly stated that the dumping symptoms following carbohydrate-rich foods act as a deterrent to eating, and are an integral component of the mechanism of action of the Roux-en-Y gastric bypass. After the duodenal switch procedure, patients can consume a wide variety of foods, and can ingest a volume approximately half of their preoperative intake without the fear of dumping. This permits restoration of social functioning and good quality of life.

In conclusion, the duodenal switch provides excellent weight loss with preservation of good alimentation even in the superobese. This is accomplished with acceptable operative mortality and minimal dietary limitations and metabolic sequelae. The results of this study should remove the inhibitions that exist about the use of the duodenal switch procedure as treatment for patients with morbid obesity.

Table 1. Demographic data for the total, female, and male patients. Continuous data are shown as mean (S.D.).

	Total patients	Female	Male	P value*
Number of patients	701 (100%)	549 (78.3%)	152 (21.7%)	-
Age (years)	42.3 (10.4)	41.9 (10.3)	43.5 (10.7)	0.1
Weight (lbs)	331.2 (73.4)	314.9 (57.7)	390.4 (91.7)	<0.001
Excess body weight (lbs)	191.3 (66.9)	180.3 (55.3)	231.1 (87.2)	<0.001
BMI (kg/m^2)	52.3 (9.6)	52.1 (8.9)	55.1 (11.3)	<0.001

P values are for the comparison of males versus females and were calculated using Student's t-test.

Table 2. Postoperative weight loss for the total study population.

Follow-up Interval	**6 MONTHS**	**12 MONTHS**	**36 MONTHS**	**≥ 60 MONTHS**
Number of Patients	435	333	71	50
WEIGHT LOST (lbs)				
Mean (S.D.)	89.2 (25.9)	126.9 (40.6)	131.4 (49.5)	117.9 (45.9)
Median	86	122	120	103
EBWL (%)				
Mean (S.D.)	49.6 (15.5)	68.7 (14.2)	72.8 (18.5)	66.3 (16.7)
Median	48.3	69.0	74.7	67.2
BMI (kg/m^2)				
Mean (S.D.)	38.4 (7.3)	32.4 (6.2)	31.1 (6.7)	32.5 (6.8)
Median	37.3	31.7	29.7	30.7

Table 3. Weight loss in patients with a preoperative BMI < 50 kg/m^2 and BMI ≥ 50 kg/m^2.

Follow-up Interval	**6 MONTHS**	**12 MONTHS**	**36 MONTHS**	**≥ 60 MONTHS**
Preoperative BMI < 50 kg/m^2				
N	173	134	29	20
Weight loss (lbs)				
Mean (S.D.)	75.2 (16.1)	102.4 (22.3)	104.4 (24.7)	91.9 (27.5)
Median	75	102	105	90.5
%EBWL (%)				
Mean (S.D.)	55.8 (10.8)	75.7 (14.3)	75.6 (15.2)	70.9 (15.3)
Median	55.4	75	75.2	70.4
BMI (kg/m^2)				
Mean (S.D.)	32.1 (3.7)	27.7 (3.4)	27.7 (3.7)	28.3 (3.7)
Median	31.7	27.7	27.7	28.2
Preoperative BMI ≥ 50 kg/m^2				
N	262	199	42	30
Weight loss (lbs)				
Mean (S.D.)	98.5 (27.1)	143.4 (41.8)	149.9 (53.9)	135.3 (47.7)
Median	97	137	141	139
%EBWL (%)				
Mean (S.D.)	44.6 (8.7)	63.9 (11.9)	70.9 (20.4)	63.3 (17.1)
Median	44.9	63.9	70.9	65.8
BMI (kg/m^2)				
Mean (S.D.)	42.6 (6.2)	35.6 (5.7)	33.5 (7.3)	35.4 (6.9)
Median	41.4	34.8	32.8	34.2

Table 4. Serum nutritional and metabolic measures. Data are shown as mean (S.D.).

Follow-up Interval	**PREOP.**	**6 MONTHS**	**12 MONTHS**	**36 MONTHS**
Serum Albumin				
Number of Patients	646	339	255	58
Serum Albumin (g/dL)	4.1 (0.3)	3.9 (0.5)	3.9 (0.5)	4.1 (0.4)
Within Normal Range (3.2-5.0g/dL) (%)	99.7%	93.5%	94.1%	98.3%
Serum Hemoglobin				
Number of Patients	658	343	256	60
Serum Hemoglobin (g/dL)	13.6 (1.2)	13.0 (1.2)	12.5 (1.3)	11.9 (1.6)
Within Normal Range (%) (Female: >12.0 g/dL) (Male: >13.8 g/dL)	88.6%	75.8%	63.7%	51.7%
Serum Calcium				
Number of Patients	660	340	256	58
Serum Calcium	9.2 (0.6)	9.0 (0.5)	8.9 (0.5)	8.6 (0.6)
Within Normal Range (3.2-5.0g/dL)* (%)	96.2%	89.1%	79.3%	70.7%

Table 5. Dietary intake and bowel frequency.

Follow-up Interval	**PREOP.**	**6 MONTHS**	**12 MONTHS**	**36 MONTHS**	**≥ 60 MONTHS**
Volume of Food Ingested (% of preoperative amount)					
Number of Patients	-	418	315	63	47
Mean (S.D.)	-	41.7 (14.8)	52.6 (16.6)	62.9 (19.5)	62.7 (18.8)
Median	-	40	50	50	65
Caloric Intake (calories/d)					
Number of Patients	-	258	194	30	-
Mean (S.D.)	-	1137.5 (486.9)	1363.6 (537.6)	1642.5 (710.9)	-
Median	-	1095	1297	1582	-
Bowel Frequency (Number of bowel movements/day)					
Number of Patients	43	421	316	65	48
Mean (S.D.)	1.9 (0.9)	2.7 (1.6)	2.6 (1.5)	2.8 (2.2)	2.8 (1.8)
Median	2.0	2.5	2.0	2.0	2.5

Table 6. Demographic factors associated with perioperative mortality. Continuous variable data are shown as median (range).

	Perioperative Mortality	No Perioperative Mortality	P value
Male:Female	6:4	146:545	0.009*
Age at operation (years)	51 (33-65)	42 (16-71)	0.01**
Body mass index (kg/m^2)	63.5 (47-76)	51 (34-95)	0.004**

* P value calculated using Fisher's exact test.

** P value calculated using Mann-Whitney test.

Figure 1. The duodenal switch procedure as performed at the University of Southern California for the treatment of morbid obesity. The operation consists of a 75% longitudinal gastrectomy, creation of an alimentary limb approximately 50% of total small bowel length, and a common channel length of 100 cm. A cholecystectomy is routinely performed.

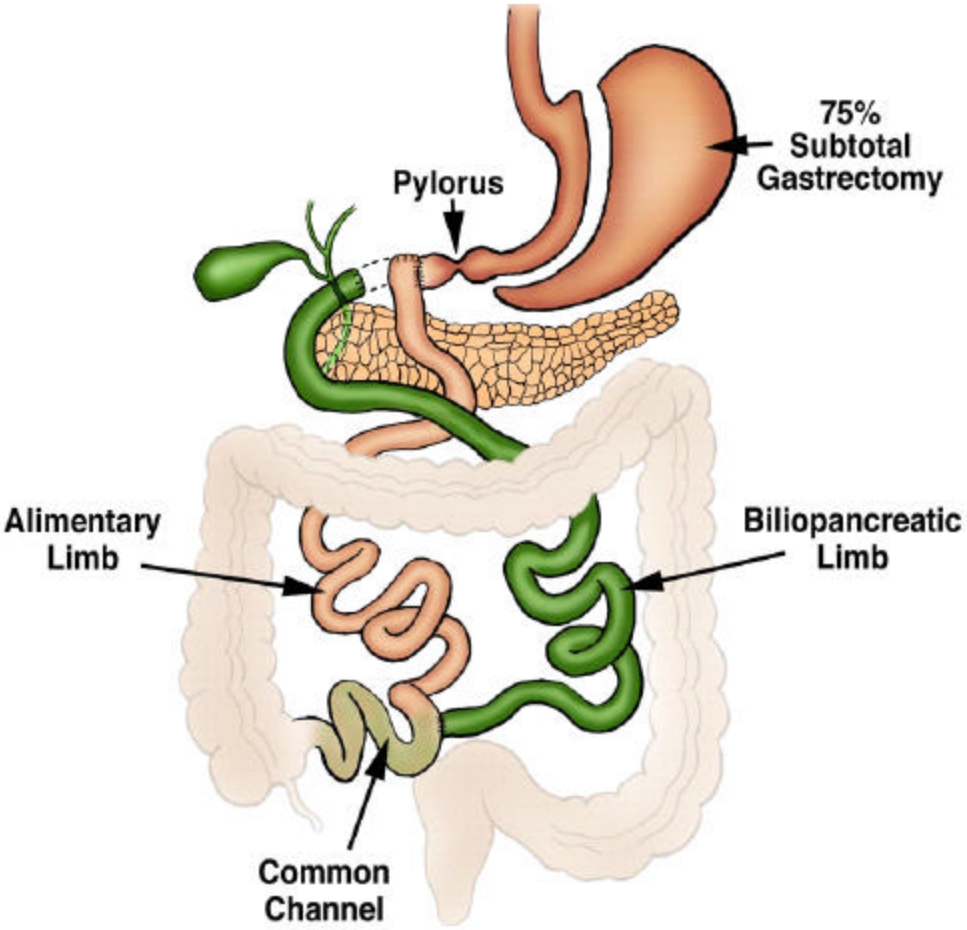


Figure 2. The longitudinal gastrectomy is performed by resecting along a line parallel to, and approximately 2 cm from, the lesser curvature. This produces a tubularized stomach of approximately 100 cc.

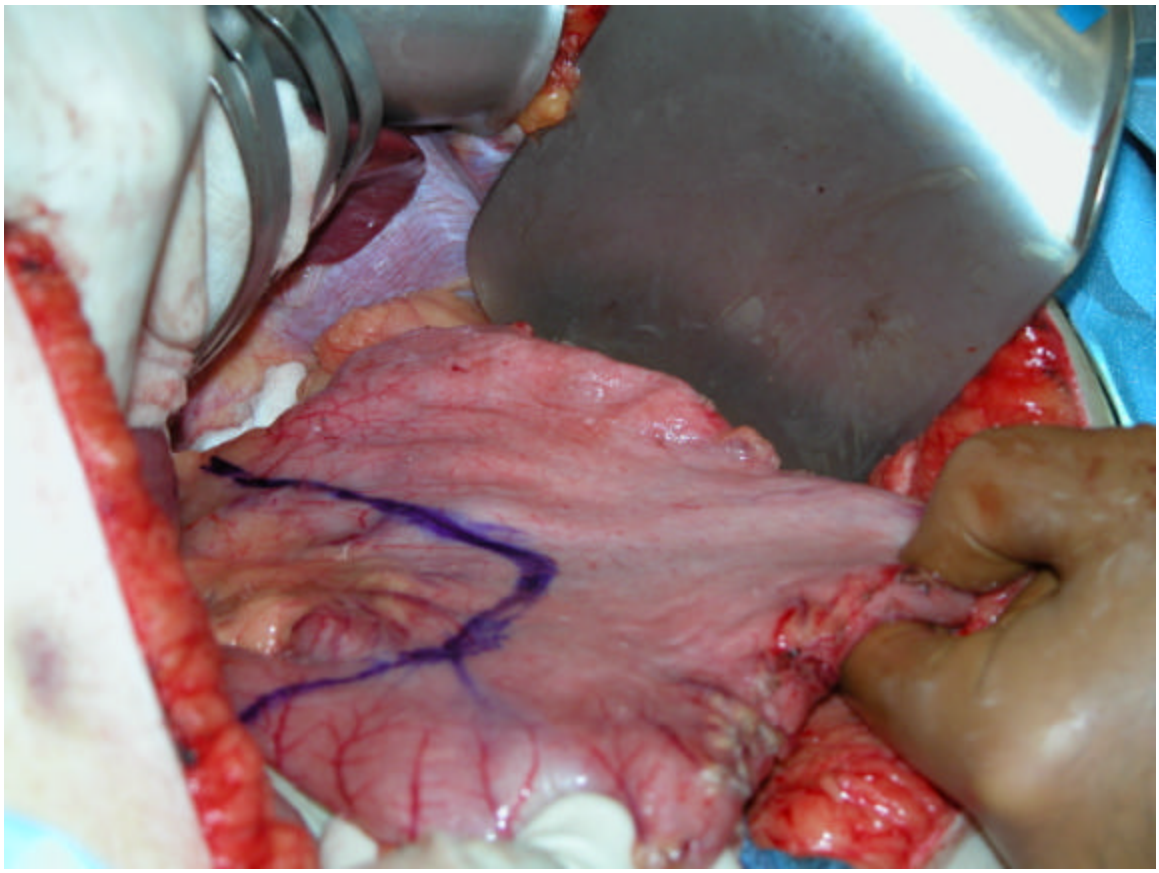


Figure 3. Air insufflation of the retrocolic duodenoenterostomy anastomosis. Note the lack of tension at the suture line.

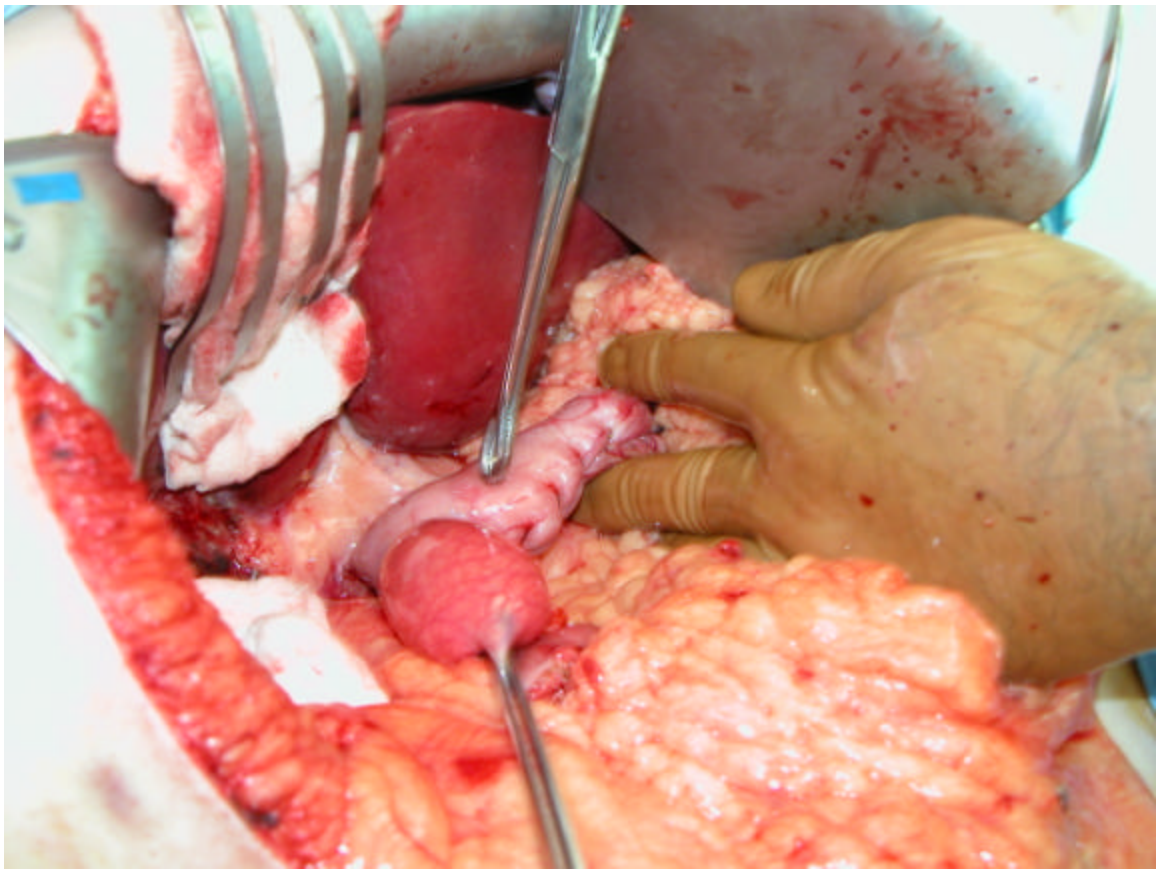


Figure 4. Bar graph showing the yearly accrual rate of patients who had a duodenal switch procedure as their primary weight loss operation during the period of the study. The number of patients per year is shown above the bar.

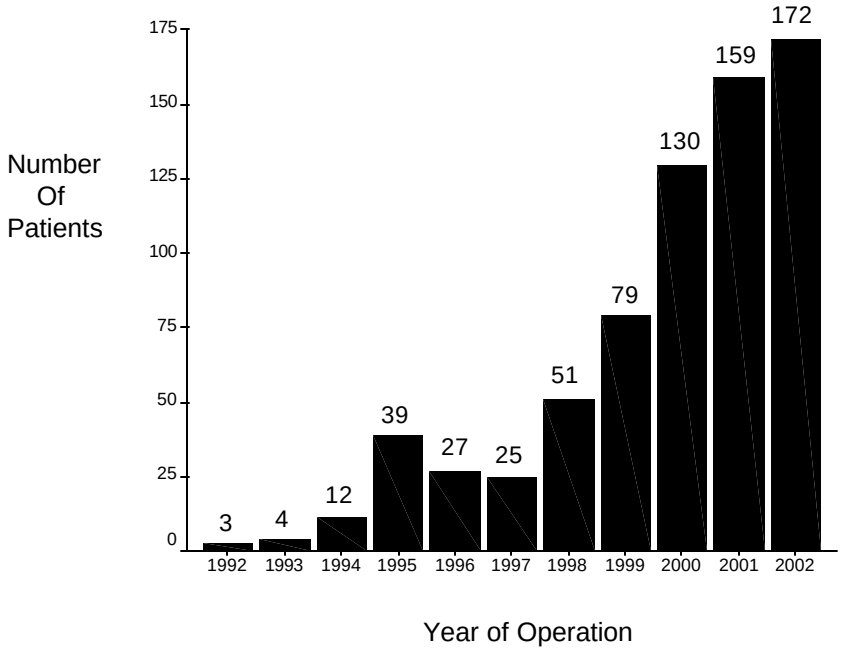


Figure 5. Percent excess body weight loss (%EBWL) for all patients. Graph shows mean and 95% confidence intervals for the mean.

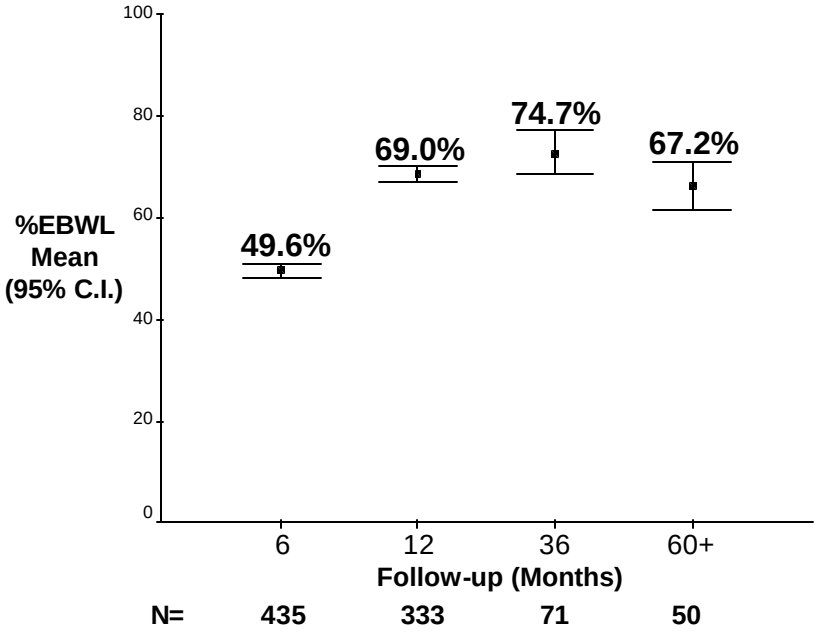


Figure 6. %EBWL for females (solid line) versus males (dotted line).

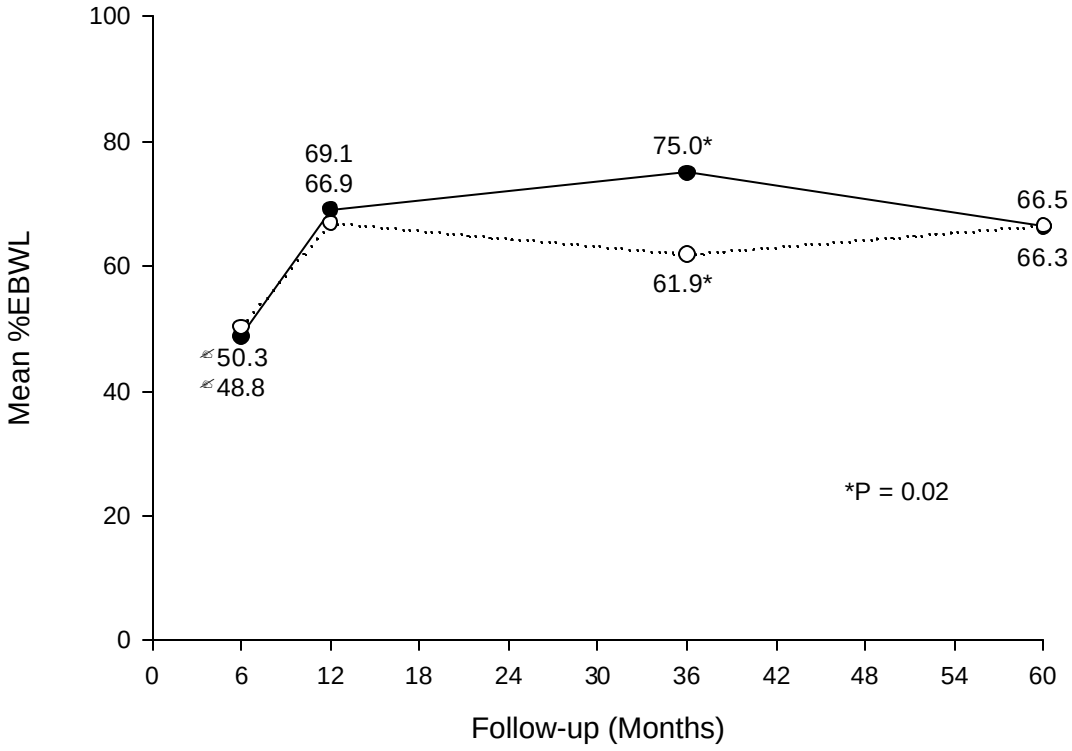


Figure 7. %EBWL and preoperative BMI <50 kg/m^2 (solid line) or $\geq$ 50 kg/m^2 (dotted line).

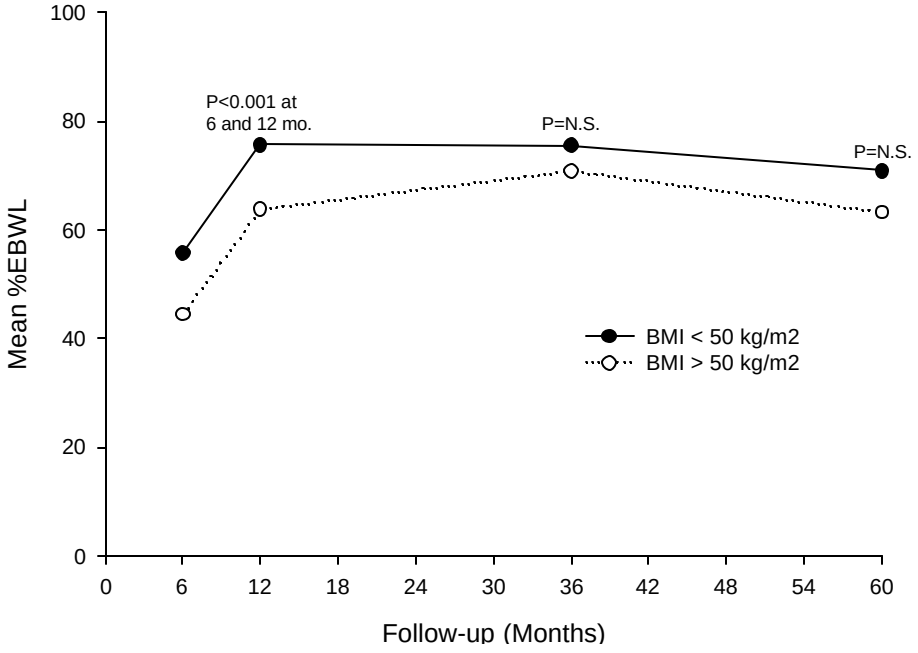
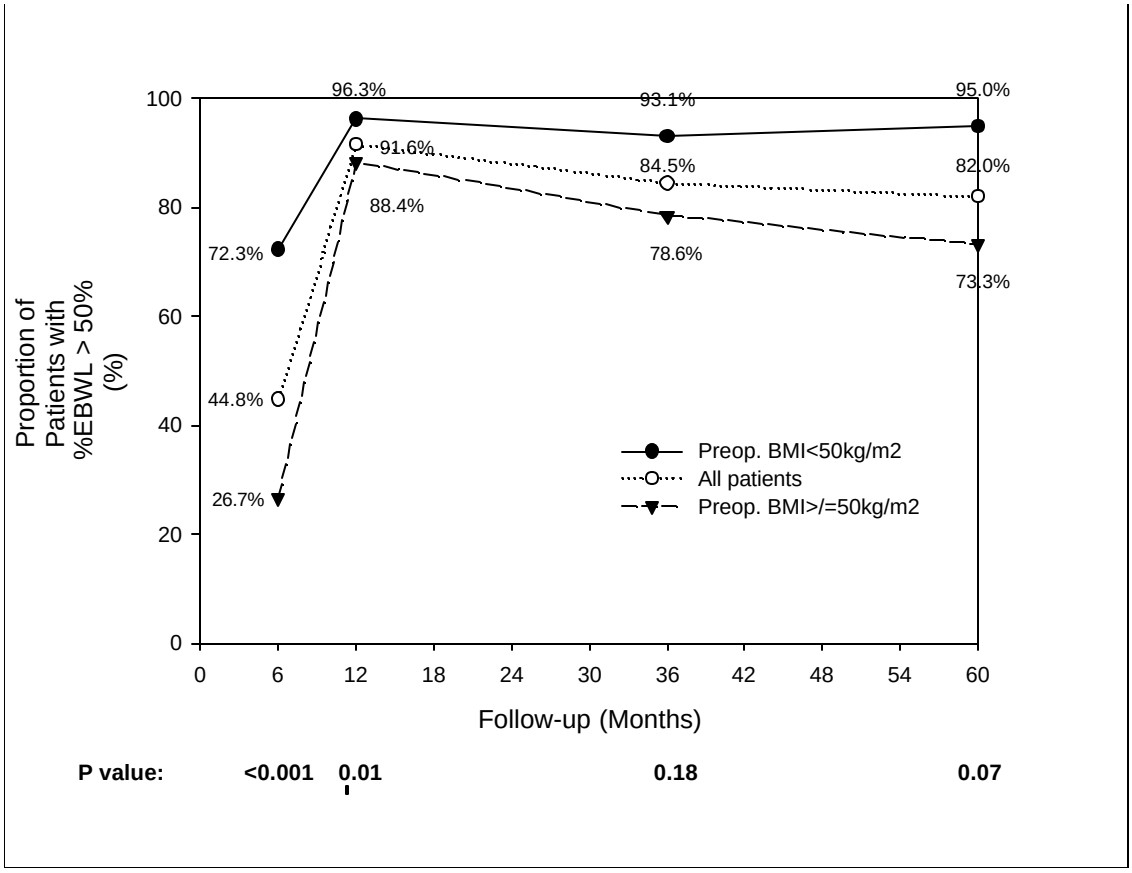


Figure 8. Proportion of patients with a successful outcome, defined as %EBWL $\geq$ 50%. The solid line shows patients with a preoperative BMI < 50 kg/m^2 (morbidly obese), the dotted line shows the total patients, and the dashed line shows patients with a preoperative BMI $\geq$ 50 kg/m^2 (supermorbidly obese). P values for the comparison of the super morbidly obese patients with the morbidly obese patients are shown at the bottom of the graph at the specific follow-up intervals (Fisher's exact test).



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