

Biliopancreatic Diversion with a Duodenal Switch

Douglas S. Hess MD, FACS; Douglas W. Hess MD

Wood County Hospital, Bowling Green, OH, USA

Background: This paper evaluates biliopancreatic diversion combined with the duodenal switch, forming a hybrid procedure which is a combination of restriction and malabsorption.

Methods: The evaluation is of the first 440 patients undergoing this procedure who had had no previous bariatric surgery. The mean starting weight was 183 kg, with 41% of our patients considered super morbidly obese (BMI > 50).

Results: There was an average maximum weight loss of 80% excess weight by 24 months post-operation; this continued at a 70% level for 8 years. Major complications were found in almost 9% of the cases. There were two perioperative deaths, one from pulmonary embolism and one from acute pulmonary obstruction. There were 36 type II diabetics, all of whom have discontinued medication following the surgery. Seventeen revisions were performed to correct excess weight loss and low protein levels. There have been no marginal ulcers, no cases of dumping syndrome, no foreign material used, and the procedure is a pyloric saving procedure which is functionally reversible.

Conclusions: This operation has vastly improved the lives of seriously obese patients with many comorbidities. All type II diabetics have essentially been cured of their disease. The procedure was tolerated well and patients are quite satisfied. There was minimal regain of weight with this method. © 1998 Lippincott-Raven Publishers.

Key words: Biliopancreatic bypass, duodenal switch procedure, malabsorption, morbid obesity, vertical gastrectomy, pylorus preservation.

Introduction

In 1988, using a combination of Dr. Scopinaro's biliopancreatic diversion (BPD) and Dr. DeMeester's duodenal switch procedures, we developed a hybrid operation which has the advantages of the

BPD without some of the associated problems. This operation is now used by us for all our bariatric patients, both in primary surgical procedures and reoperations.

The difficulty of establishing an operation that has both long- and short-term success is well known. Bariatric surgery is either restrictive or malabsorptive in nature, each with its own advantages, disadvantages and complications. While trying to find a procedure that would produce better long-term results and fewer failures, i.e. regain of weight, we began to look at the Scopinaro BPD.¹ First of all we considered it only for reoperations on failed restrictive procedures. Our first cases were reoperations with the standard Scopinaro BPD and a few without a distal gastrectomy. However, the dense adhesions found in the upper gastric area of previously stapled patients caused difficulty in placing the anastomosis and we were troubled with marginal ulcer formation. We considered a method to anastomose the ileum to the duodenum away from the site of the previous surgery. While searching the literature on the subject of duodenogastric reflux, we found DeMeester's article about the duodenal switch procedure² and adapted it to our use.

The first patient to have a BPD with a duodenal switch procedure was a male patient who had had a transverse gastroplasty 9 years earlier, in 1979. He was 190 cm tall and at the time of his surgery in 1979 he had weighed 166 kg. That surgery eventually failed due to staple-line disruption, and his weight had increased to 206 kg by the time of his reoperation in March, 1988. He also had developed chronic heart failure, shortness of breath, and was no longer able to perform many daily activities. Presently, he is approximately 9.5 years after the conversion to a duodenal switch with a BPD, weighs 125 kg, and is free from problems associated with his obesity. Due

Correspondence to: Douglas S. Hess, MD, 640 South Wintergarden Rd., Bowling Green, Ohio 43402, USA. Tel: (+1) 419 352 1452; Fax: (+1) 419 352 1244.

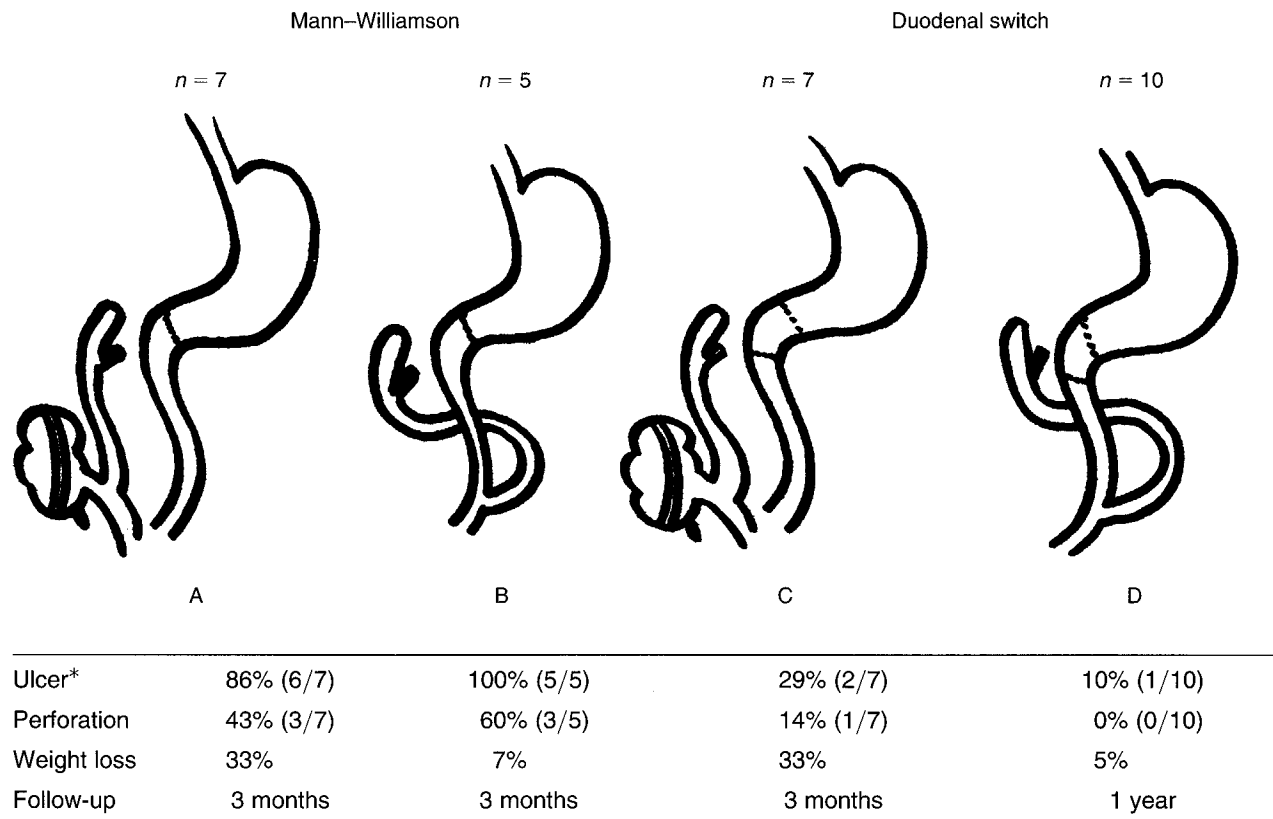
to the success of our reoperations, we decided to use this procedure for our primary operation for both the morbidly and super morbidly obese patients.

Our first duodenal switch primary procedure was performed on a morbidly obese male patient (BMI, 46) in May, 1988. At his most recent weighing on October 29 1997, his excess weight loss was 88%, BMI was 26, and his percent of ideal weight (% IW) was 112. The first super morbidly obese patient (BMI 58.7) was a female operated in June, 1988. At her last weighing on June 10 1997, her excess weight loss was 78%, BMI was 30, and her % IW 137. Both of these patients are more than 9 years post-operation and are doing well. This operation is now our procedure of choice for surgical correction of morbid and super morbid obesity.

This paper will be limited to our first 440 patients and to primary procedures only. Reoperations are not included.

Rationale for Duodenal Switch

Examining the experimental work on dogs of Dr. DeMeester *et al.*² as described in the Figure 1, it is evident that a small segment of proximal duodenum protects against marginal ulceration. The surgical procedures for all groups are basically the same, except that the dogs in groups C and D had a short segment of proximal duodenum left in place before the jejunostomy. The dogs in groups A and B had a high incidence of ulcers, perforation and weight loss. Groups C and D had significantly fewer ulcers and almost no perforations; however, the weight loss did not change. Using this data and DeMeester's report of patient cases (i.e. duodenal switch) we believed that the combination of the BPD and the duodenal switch is a logical progression of this procedure. To achieve the gastric restriction required by Scopinaro's BPD a vertical gastrectomy is performed; this removes a large portion of the fundus and



*A vs C *P* = 0.05 B vs D *P* = 0.002 A vs D *P* = 0.003

Figure 1. Results of four diversion procedures with their effect on ulcer incidence, perforation and weight loss (reproduced, with permission, from reference 2).

also reduces acid formation, thus helping to prevent marginal ulceration (Figure 2).

Patient Selection and Preoperative Evaluation

Patients selected for surgery in this cohort were aged 16–62 years (average 39 years). All patients were 45.5 kg or more above their ideal weight using the 1983 Metropolitan height and weight tables. The presence of co-morbidities is an additional indication for surgery. Patients with combinations of co-morbidities with a lower excess weight are occasionally candidates for surgery. However, most patients are more than twice their ideal weight at the time of surgery (Table 1).

All patients view a video explaining the surgical procedure and possible complications. They are

Table 1. Preoperative data: morbid obese patients

	Average values (<i>n</i> = 440)
Sex (M/F)	95/345
Age (years)	40
Weight (kg)	138.3
Height (cm)	166.1
Body mass index (kg/m ²)	50
Percent ideal weight	222
Excess weight (kg)	76

later seen by the physician for an extended interview and second explanation of the procedure, including expectations. They have the usual preoperative complete blood count, chemistry profiles, cardiac evaluation, and X-rays. They are then seen by an internist for a medical evaluation. The patients are encouraged to attend one of the monthly support meetings before surgery, which is also attended by a physician. The meetings allow the prospective patients to acquire additional information and talk to patients who have had this surgery.

Procedure

Under general and epidural anesthesia a midline incision is used in the upper abdomen from the xiphoid to the umbilicus. A Gomez retractor is put in place, and the abdomen is explored. We start with an appendectomy, and complete measurement of the small bowel along the antimesenteric border with a mild stretch between two Babcock clamps, from the cecum to the ligament of Treitz. A silk suture is placed in the margin of the bowel at the estimated proximal common channel and the proximal end of the alimentary limb. These measurements may be changed after complete measurement of the bowel. The length of the alimentary limb is calculated by multiplying the bowel length by 40% to determine the distance from the cecum to the ligament of Treitz. Using 25 cm increments, the final length of the alimentary canal is the nearest to the 40% area. Generally, the alimentary canal will be 250 cm, 275 cm or 300 cm. Occasionally 225 cm or 325 cm will be used in patients with an unusually short or long small bowel. Since the epidural anesthesia may cause spasm of the small bowel, it is not used until after the measurements are completed.

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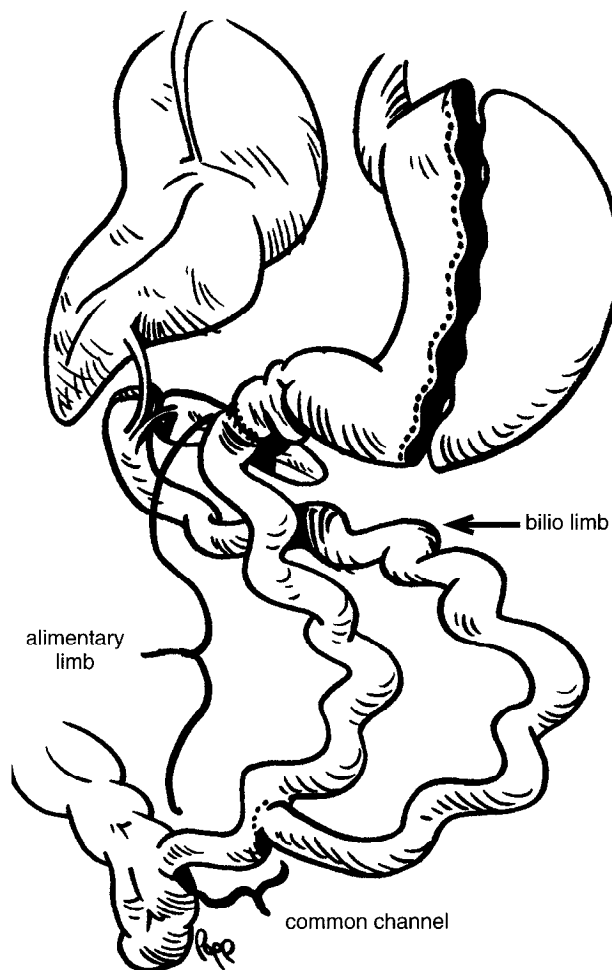


Figure 2. Biliopancreatic diversion with duodenal switch procedure.

upper abdomen. The left triangler and Falciform ligaments of the liver are incised to allow retraction of the liver away from the stomach and it is held with gauze and a liver retractor. We open into the lesser sack by transecting a couple of short gastrics at the mid greater curvature of the stomach. With a tripolar cautery (i.e. a bipolar cautery with a knife for cutting cauterized tissue) all the short gastrics are transected from the pylorus to the esophagus, freeing up the entire greater curvature portion of the stomach. Blood vessels are transected along the greater curvature side of the duodenum for about 5 cm distal to the pylorus, and a Penrose drain is passed around the duodenum at this point. The Salem tube is removed and a 40 F dilator, to be used as a sizer, is passed into the stomach, along the lesser curvature, and through the pylorus into the first part of the duodenum. The greater curvature side of the stomach is held upward and to the left by an assistant, using Babcock clamps. We size the new stomach by placing the ILA-100 stapler along the dilator, starting from the distal stomach a few centimeters proximal to the pylorus, directed upwards, separated from the dilator by a space of one to two finger breadths. This stapling is repeated three or four times as needed to remove the entire greater curvature side of the stomach. Bleeding points along the staple row are oversewn with figure-of-eight silk sutures. Then the staple row is inverted by a continuous suture using a serosal-to-serosal suture (U.S. Surgical O-Biosin). The dilator is removed and the duodenum is transected as far distal to the pylorus as possible (generally 4–5 cm) with an ILA 52; the Salem tube is then reinserted.

The volume of the stomach is measured in all cases at this time by filling the stomach with saline and methylene blue dye. With one hand we press against the esophagus to stop reflux of the saline; we do not dissect around the esophagus. After the stomach is distended we withdraw the saline and this amount is considered to be the volume of the stomach; this procedure also allows us to check for possible leaks.

A cholecystectomy is performed in all patients who still have a gallbladder, in the routine manner. The small bowel which was previously marked for the alimentary limb is transected with an ILA 52, and the mesentery is divided with the tripolar cautery until the distal ileum can be mobilized up to the pyloric area. The distal ileum is taken retrocolic to the right of center up to the duodenum which is still attached to the pylorus

and is anastomosed to this duodenum with a Valtrac anastomosing ring end-to-end using a 1.5 mm gap and a 25 mm diameter Valtrac. The mesentery is sutured to the posterior peritoneal wall to prevent internal hernias. The proximal ileum is taken distally to the previously marked area on the distal ileum and an end-to-side anastomosis is performed with a Valtrac anastomosing ring (1.5 mm gap and 25 mm diameter) and the mesentery is closed with a running suture. The abdomen is closed in the usual way and a drain is generally placed in the gallbladder bed area.

Several concurrent procedures are performed during this surgery as illustrated in Table 2.

Measurement and Size

After resection of the greater curvature we prefer that the volume of the stomach is around 150 ml (generally between 100 ml and 175 ml). We size the stomach with a #40 dilator along the lesser curvature, and we stay 1.5 to 2 finger breaths away from the dilator towards the greater curvature side when we apply the ILA-100 stapler. In general, this will give a stomach that will fall in the desired range. The serosa-to-serosa suture reduces the size of the stomach; this is an important factor in early weight loss because as time passes the stomach volume will enlarge.

We believe that the total length of the alimentary limb (from the cecum to the stomach) should be approximately 40% of the total length and that the common channel (the distal portion of the alimentary limb just beyond the anastomosis of the biliary limb) should be somewhere around 10% of the total small bowel length. The common channel is made 50, 75 or 100 cm, whichever seems to be the most appropriate for each patient.

Table 2. Concurrent procedures, by type and number performed

Type	n
Cholecystectomy	330
Appendectomy	278
Hernia repair	25
Tubal ligation	11
Liver biopsy	7
Incidental splenectomy	4
Hiatus hernia repair	2
Oophorectomy	2

The length of our alimentary limb is always calculated in 25 cm increments: 250, 275, 300 cm, etc. Table 3 shows the common channel, the alimentary limb and the approximate number of cases in that group. In addition, it indicates the average length of the bowel, the patient's weight and the stomach volume illustrating that in general, the measurements are close to 40% alimentary canal and 10% common channel. These are only guidelines and every patient is evaluated individually, at the time of surgery in terms of age, weight, and the number of co-morbidities; these factors influence our decision on the above sizes. The appropriate volume of the stomach, and

the lengths of the Roux-en-Y limbs and bilio-limbs have been debated. Table 3 shows the first 382 cases of primary BPD with duodenal switch, and it indicates the variety of measurements in lengths with similar bowel lengths in percentages. The authors believe that the percentage should be considered when deciding how long the limbs should be; as long as consistency is maintained the method of measurement is insignificant. Table 4 illustrates that the variation in bowel length between patients may be more than 100%. If the same lengths are used in all patients then some will be too short and some will be too long. The exact appropriate size is illusive and is yet to be

Table 3. Measurements of the first 382 primary BPD with duodenal switch patients

CCH/AL (cm)	<i>n</i>		Average Measurements (kg/cm/cc)	AL/CCH (%)
50/225	6	Weight (kg) Bowel length (cm) Stomach volume (ml)	139 (116–175) 545 (516–589) 133 (110–160)	41/9
50/250	52	Weight (kg) Bowel length (cm) Stomach volume (ml)	129 (90–185) 620 (519–760) 172 (75–305)	40/8
50/275	32	Weight (kg) Bowel length (cm) Stomach volume (ml)	132 (102–208) 697 (640–814) 179 (100–250)	39/7
50/300	19	Weight (kg) Bowel length (cm) Stomach volume (ml)	139 (98–194) 800 (706–900) 193 (125–255)	37/6
75/250	26	Weight (kg) Bowel length (cm) Stomach volume (ml)	130 (90–164) 612 (473–713) 164 (120–235)	41/12
75/275	122	Weight (kg) Bowel length (cm) Stomach volume (ml)	140 (92–266) 708 (577–858) 164 (100–250)	39/10
75/300	83	Weight (kg) Bowel length (cm) Stomach volume (ml)	148 (92–232) 795 (497–985) 164 (100–240)	39/9
100/300	35	Weight (kg) Bowel length (cm) Stomach volume (ml)	129 (89–225) 804 (635–997) 193 (125–250)	37/12
75 and 100/325	3	Weight (kg) Bowel length (cm) Stomach volume (ml)	165 (132–186) 877 (856–888) 192 (125–250)	36/11
100/350	4	Weight (kg) Bowel length (cm) Stomach volume (ml)	133 (90–168) 860 (826–900) 189 (135–245)	40/12

CCH, common channel; AL, alimentary limit.

Table 4. Total small bowel length

	<i>n</i>	Maximum length (cm)	Minimum length (cm)	Average length (cm)
Female	342	997	473	707
Male	98	1065	497	776
Both	440	1065	473	722

discovered. Figure 3 shows weight loss according to the sizes used in Table 3.

The information presented at the bariatric surgery meeting in June 1997³ (and by personal communication) in Chicago by Scopinaro indicated that by increasing the length of the alimentary limb the absorption of protein increases substantially, whereas increasing the size of the common channel alone does not necessarily increase the amount of protein absorption, but it does reduce fat malabsorption. Scopinaro believes that most of the digestive juices and bile are reabsorbed before they reach the common channel and that an increase in the alimentary canal would be a method of increasing protein absorption without reducing the selective malabsorption of fat and weight loss capabilities. However, as the length of the alimentary limb is increased the absorption of carbohydrates is increased also. We feel that this is probably correct and in general it supports our method of using 40% for the guideline of the length of the alimentary canal. It appears that the alimentary canal can be made longer, the common channel made relatively short, so that a selective malabsorption of fat will occur

while adequate absorption of protein is maintained.

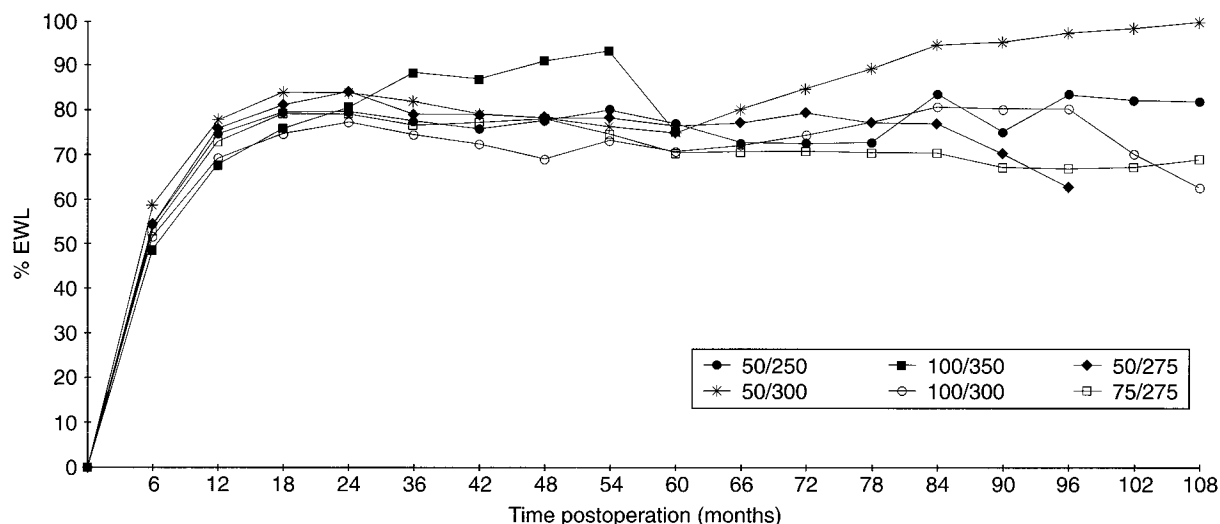
Time

Time in any surgical procedure is of importance. In the first 114 cases that we performed, the average operative time was 199 minutes. After we had performed 213 cases our average time was 187 minutes. In the last 115 operations our operative time was 158 minutes; this is our current average.

These improvements in operative time are partly due to newer techniques. We now measure the small bowel at the beginning of the operation and remove the appendix. We use a tripolar cautery to take down all the short gastrics along the greater curvature of the stomach. We rarely tie any short gastrics. This has reduced the blood loss and operative time. We use this same method for dividing the mesentery in the small bowel. There are two anastomoses, both of which are made with the Valtrac ring anastomoser. This has decreased the operative time significantly and reduced possible complications. All of these factors, technical and mechanical improvements, have made this operation more efficient.

Blood Loss

Blood loss has not been excessive and in most cases we have the patient donate an autologous

**Figure 3.** Percent excess weight loss with time.

unit of blood 2 weeks prior to surgery which we give back at the time of surgery. Generally no further blood is needed. We have given 342 units of autologous blood in our first 440 patients. There are some patients who were either not able to give autologous blood or required extra blood, and we have used a total of 26 units of banked blood for our 440 primary surgeries, excluding two patients who had intraabdominal bleeding postoperatively and required surgery to control the bleeding. In most cases blood loss has been approximately 300 ml.

Follow-up

In bariatric surgery, patient follow-up and weight loss results over several years are very important. Without this follow-up we would have little idea about the success or failure of the surgery we are performing. Most of our patients are on 6 month follow-up visits after the second year of surgery; therefore, we have a 6 month period in which our follow-up is current. In this series of 440 primary BPD with the duodenal switch there are six patients that we have not been able to contact for follow-up. This gives us, in this cohort, a total percentage follow-up of 98.60.

Results

The results are shown in Figure 4 by weight loss (kg), percent excess weight loss, and percent total

body weight loss. This is a graph of the average of the first 440 primary duodenal switch patients. The maximum weight loss occurred around 24 months, with about 80% excess weight loss (% EWL), and continues at a satisfactory level to 8 years. This cohort is over 9 years old, and Table 5 illustrates the number of cases which were performed each year from which this graph is taken. This graph shows the average weight loss but, we also evaluate our success according to individual patients.

Each patient is calculated individually. Table 6 consists of the grade determinants that are used for individual results and includes 361 patients. We did not include any of the patients whose last recorded weight was taken less than 9 months after surgery (these results are based on the last weight recorded, not an average). Table 6 illustrates the number of patients in the different

Table 5. Primary bariatric patients with BPD and a duodenal switch

Year	<i>n</i>
1988	3
1989	28
1990	40
1991	23
1992	45
1993	43
1994	71
1995	76
1996	72
1997	79*

*Only 39 cases from 1997 were included in this paper.

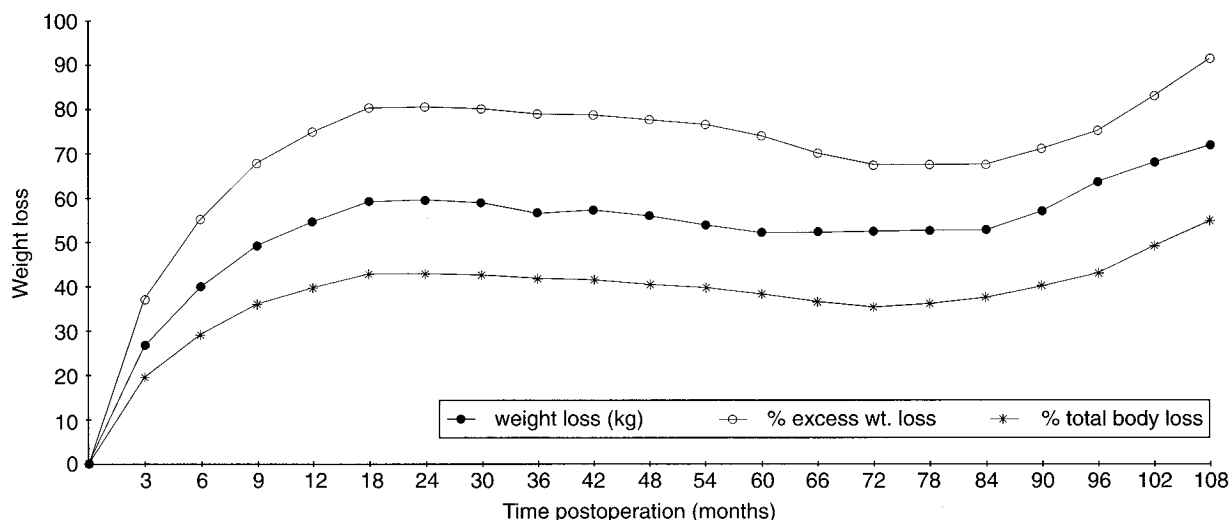


Figure 4. Weight loss in 400 primary bariatric surgery patients.

Table 6. Composite grade and results for 361 primary cases

Grade	<i>n</i>	Total (%)
Excellent	288	79.8
Good	47	13
Fair	25	6.9
Poor	1	0.3
Failure	0	0
Total satisfactory		99.7
Total unsatisfactory		0.3

Grade determinants (all minimum values): Excellent, 80% EWL; Good, 60% EWL; Fair, 40% EWL; Poor, 20% EWL; Failure < 2% EWL. Satisfactory = excellent, good, fair; unsatisfactory = poor, failure.

categories and their results with follow-up to 9 years. There are 335 patients in the 'good' and 'excellent' categories for a total of 93%. The other group falls into the 'fair' category which is still satisfactory. Most of these are considered successful, as they have had a stable weight for a long time, but did not achieve more than 60% EWL. In the 'fair' group there were 25 patients whose % EWL was 40.2–59.8 with an average of 50.2% EWL. When comparing those to the determinates in Table 6, our total of satisfactory results was 99%. Table 7 illustrates the total patients counted in different years follow-up by number of patients, number of satisfactory cases, and number in good and excellent categories at that year. Of the long-term results, there is only a small amount of regain and we have never had a patient regain weight up to their original weight. Our one patient in the 'poor' category has 35% EWL.

Of the 440 patient cohort, 301 patients have a minimum of 1 year follow-up and some have a follow-up time to as much as 9 years. The average maximum weight loss is at 23 months, with an

average maximum loss of 63.2 kg and an average of 85% EWL. Table 1 gives the demographic details of the group, total number of 440 patients with normal distribution of male/female and age. The average weight of our patients is rising, and is now 137 kg, a BMI of 50 kg/m² and 222% IW.

As illustrated in Table 5, the success of the BPD with the duodenal switch has contributed to the increasing number of cases we perform. This method of surgery has been the most successful for patient weight loss that we have used so far.

Super Morbid Obesity

By defining the super morbid obese patient to be 225% IW, or having a BMI of 50 kg/m² or more, then 41% of our patients fall into that category.⁴ Our average patient is now 138 kg and the average starting weight has recently been rising. Figure 5 shows the weight loss curve of the super morbid obese patient (BMI > 50) and indicates weight loss comparable to that of the morbidly obese group (BMI < 50); this group continues to have 70% EWL and maintains good weight loss throughout the 8-year period.

The statistical data of our 181 super morbidly obese patients is given in Table 8; the composite results of the super morbidly obese patients with at least 9 months post-surgery follow-up are also shown. No unsatisfactory results were seen and 97.3% of the patients fell into the 'good' and 'excellent' categories.

The super morbid obese patient finds it much more difficult to lose weight successfully. We believe that a restrictive procedure alone will probably not work for most super morbidly obese patients. The BPD bypass with a duodenal switch works quite satisfactorily and is used for all super morbid obese patients in our hands. These are the

Table 7. Follow-up results of BPD with duodenal switch patients, grouped according to time since surgery

Time since surgery (years)	<i>n</i>	Satisfactory	Good–excellent
8	11	11	9
7	29	29	25
6	51	51	45
5	92	92	80
4	132	132	117
3	187	186	167
2	264	263	240
1	345	344	320

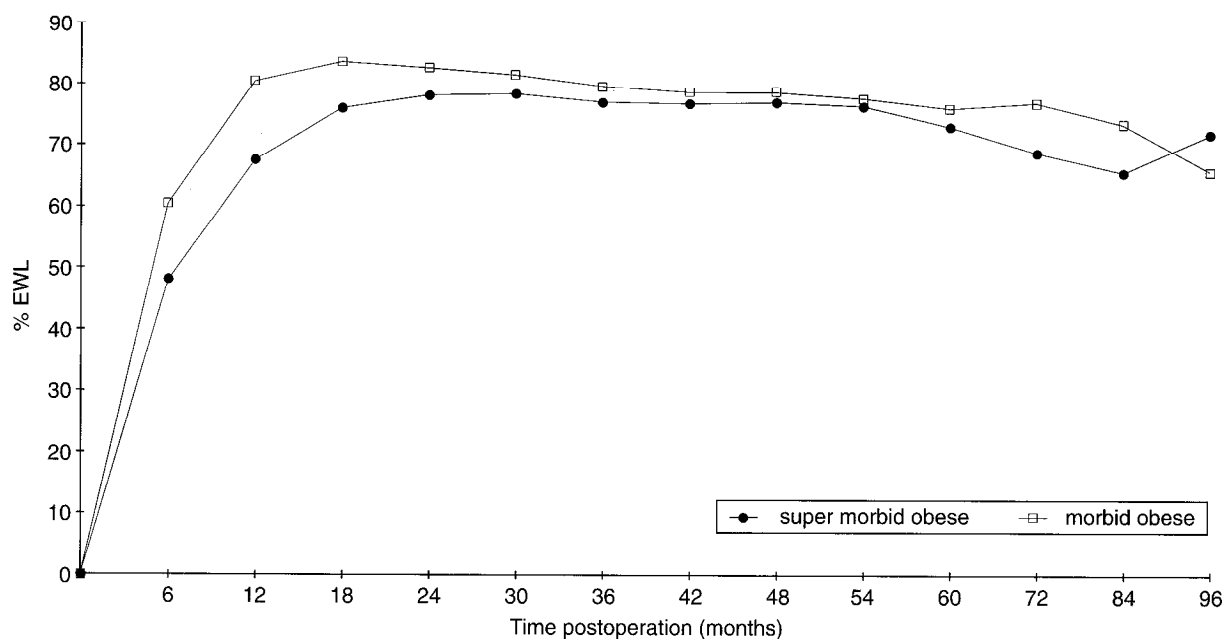


Figure 5. Weight loss shown by % EWL in morbid obese and super morbid obese patients.

Table 8. Preoperative data: super morbid obese patients

	Average values (<i>n</i> = 181)
Sex (M/F)	40/141
Age (years)	39
Weight (kg)	159.9
Height (cm)	165.8
Body mass index (kg/m ²)	58
Percent ideal weight	257
Excess weight (kg)	97.4

patients who have the most serious co-morbidities, high degree of sleep apnea, cardiac problems, diabetics etc. These are the people whose lives are threatened daily by their severe obesity and, if possible, they need to have one successful operation that will bring them down to a near-normal weight.

Complications

There are several complications that can occur in, but are not limited to, bariatric surgery. Table 9 lists these complications in our group. In addition, there is the frequent problem of atelectasis (20%) in the obese postoperative patient.

Gastric leaks are the most significant complication of bariatric surgery; this is the perforation of

some portion of the stomach or staple line which occurs after the bariatric surgical procedure. The incidence of gastric leaks has been reported to be 0.5–5% in different series of bariatric surgery. In our series of 440 cases, in the first 252 operations we had a total of eight leaks (3.1%). These occurred on both two-row or four-row staple lines with simple oversuturing of the staples.

After viewing a video by Baltasar⁵ at an annual meeting of the American Society for Bariatric Surgery, we modified our procedure for the latter 188 cases. We now use the ILA-100 in all cases which forms two rows of staples. We control bleeding edges through the staple line with a 'figure 8' suture, and then a complete serosa-to-serosa closure over the staple line inverts the mucosa from the esophagus down to the pylorus with O-Biosin (a synthetic glycomer by United States Surgical). In these 188 patients we have seen only one leak. This leak was in a patient who was very heavy and almost always required C-pap which we think may have increased the intragastric pressure, and did develop a leak on the upper portion of the stomach 2 days after discharge home on her 10th postoperative day.

We believe that the serosal-to-serosal inversion of the mucosal portion of the staple line is very important to prevent leaks in these cases. One leak out of the 188 cases brings our leak percentage down to 0.5%, which is a marked improvement

Table 9. Complications of BPD with duodenal switch

Complication	<i>n</i>	Total (%)
Medical complications (perioperative)		
Deep vein thrombophlebitis	3	0.75
Non-fatal pulmonary embolus	2	0.5
Pneumonia	2	0.5
ARDS	1	0.25
Surgical complications (perioperative)		
Splenectomy (incidental)	4	0.9
Gastric leak and fistula*	9	2.0
Duodenal leak	6	1.5
Distal Roux-en-Y leak	1	0.25
Postoperative bleeding (surgery required)	2	0.5
Abscess (not related to leaks)	1	0.25
Late complications		
Duodenal stomal obstruction	3	0.75
Small bowel obstruction	8	2

*For explanation, see text.

from our 3.1% leaks before complete inversion of the staple row. In our hands leaks can be reduced to a minimum even in complex surgery as described above by carefully inverting the staple row with a serosal-to-serosal stitch.

Gastroduodenal Leaks

The anastomosis of the ileum to the duodenum near the pylorus is high up on the right side; a difficult area to work in. This anastomosis is particular to the duodenal switch procedure. In the first 119 cases we performed a hand-sewn anastomosis with an end-to-side anastomosis double layer with Vicral and silk. Two patients developed leaks from this duodenal-ileo anastomosis (1.6%). They were both small and were closed simply by keeping the patient NPO and on i.v. fluids for about 10 days. For the past 4 years we have been using Davis & Geck's Valtrac anastomosis ring (a biofragmentable product) for this anastomosis. We have performed over 600 Valtrac ring anastomoses in this manner. Of these there were six anastomotic leaks (1%); three were treated conservatively with i.v. fluids and restricting intake by mouth, and they closed spontaneously; three required a surgical procedure to close. One had a leak and an erosion into a small artery producing massive gastro-intestinal bleeding requiring emergency surgery. The other two had what appeared to be a leak larger than

expected, and we felt that this would not close by itself.

In contrast to gastric leaks, if there are proper drains in the area of the pylorus or if the leak is small and there are no other problems, it is probably better not to operate on these leaks at the duodenum since they generally close with conservative therapy. In our 440 cases described above we have never had any leak on the duodenal stump; this does not seem to be a problem.

Distal Roux-en-Y Leaks

Leaks in the distal portion of the Roux-en-Y are significantly different, particularly when there is a long limb Roux-en-Y. Out of 550 Roux-en-Y cases we have had only one leak (0.1%). Anastomotic leaks in this area are very critical. There are two major problems with this particular area: they are difficult to diagnose and careful attention must be paid if there are elevated white blood cell counts, temperature and a tender abdomen; they are quite dangerous and can lead to generalized peritonitis and sepsis, in the single case we had the X-rays were negative but the patient continued to be septic and was therefore explored whereupon a breakdown of the stapled anastomosis at the distal Roux-en-Y was found. We exteriorized this distal breakdown and treated the patient with i.v. fluids and total parenteral nutrition. The controlled fistula was successfully closed later.

Deaths

In our series of 440 patients there have been two perioperative deaths; both underwent autopsy. One died on the 14th postoperative day with a massive pulmonary embolus thought to be 24-hours old. The second patient died from a respiratory arrest with bilateral bronchial obstruction. Both were quite large and had sleep apnea and respiratory insufficiency (Table 10). We have had three late deaths; time post surgery and cause of death are indicated (Table 10).

Revisions

We have performed a total of 17 revisions. All of these were performed along with other surgeries such as incisional hernias, panniculectomies, and hysterectomies (Table 11). The revisions are for low protein, excessive weight loss, excessive diarrhea or in some cases less weight lost than the patient expected. Table 12 shows the results: eight patients were revised primarily because of low protein and excessive weight lost; two patients had excessive diarrhea, low protein and excessive weight loss – these were treated by lengthening the bowel; seven patients had good weight loss but they felt they wanted to lose more and they were still 23 kg or so above ideal weight, and so the common channel was shortened. Lengthening the bowel works quite well and stops the excessive weight loss and low protein. However, shortening the common channel a year or so after primary surgery may not

Table 11. Surgeries performed in the postoperative period

<i>n</i>	Operation performed
117	Panniculectomies
108	Incisional hernias
9	Inguinal hernias
16	Distal Roux-en-Y revisions*
11	Abdominal hysterectomies
7	Bilateral thigh reduction
5	Upper arm reduction

*Revisions are also listed. We have performed 117 panniculectomies on the first 440 primary switch patients in the postoperative period. All of these patients had their panniculectomy performed together with one of the hernias listed in Table 10. In addition to the hernias all the other procedures listed were performed during these panniculectomies.

Table 12. Revisions

<i>n</i>	Reason	Procedure
8	Low protein and excess weight loss	Lengthen bowel
2	Excess diarrhea	Lengthen bowel
7	Poor weight loss	Shorten common channel

All revisions were performed along with hernia repairs, panniculectomy, or other surgery.

give satisfactory additional weight loss which is generally not much more than around 9 kg.

There has been one reversal in our primary switch patients; this patient was several states away and became concerned about not being able

Table 10. Perioperative and late deaths

Patient	Early deaths (two)*		Late deaths (four)		
	BMI	Cause of death	Weight (kg)	Time postoperation (months)	Cause of death
1	74	Pulmonary bronchial obstruction			
2	58	Massive pulmonary embolus			
1			266	7	Myocardial infarction
2			201	15	CVA
3			180	26	Septic shock (infected panniculus)
4			145	10	Fatty liver, liver failure, renal failure, ARDS, multiple organ failure

*Five hundred and twenty cases, death rate 0.4%.

to have follow-up surgeons easily available to her in her area. Three months after her original surgery the small bowel portion was reversed. She has been doing well and now a year or so later is wishing she had not had the small bowel portion changed.

Laboratory

The average laboratory values are taken from the first 100 consecutive patients of this cohort covering a period of 5 years. Intermittent studies of CBC, chemistry profiles and vitamin studies are included. Figure 6 shows the averages of the lipids at the preoperative period compared to the levels 3 months, 6 months and 1 year after surgery. This graph indicates an average level of lipids in the normal range at the start of surgery. There is a lowering of the cholesterol and triglycerides, and at the same time the high density cholesterol (HDL) remains the same, improving the average ratio of low density cholesterol to high density cholesterol (LDL/HDL) from 3 to 1.5.

Patient #444 is an unusual case in that her main pathology was her high lipid levels. She had been hospitalized several times with pancreatitis due to her elevated lipids. On the last admission prior to surgery her cholesterol was 880 mg/dl and her triglycerides were 5000 mg/dl. This patient was 44 kg above ideal weight and at the time of surgery her cholesterol was 440 mg/dl and her triglycerides were 2000 mg/dl. The high lipid abnormality was an important co-morbidity

as an indication for surgery. This patient had had a cholecystectomy several years before and since that surgery she had been troubled with post-prandial diarrhea, which was a concern to us. For this reason we increased the length of her common channel to 100 cm and the total length of the alimentary channel to 300 cm. This increase of bowel lengths has reduced her total weight loss (75% EWL in 12 months and has stabilized, for the last few years, at 50% EWL) but she now has no difficulty with diarrhea and her post-prandial diarrhea has been corrected. Figure 7 shows an 8 year follow-up of this patient's lipids. All lipids have fallen to normal levels and remained normal to this date. The high density cholesterol level remains constant, which has markedly improved the LDL/HDL ratio.

One interesting finding was that in taking our patients' history prior to surgery, we found that of the patients that had had a cholecystectomy in the past, between 10 and 15% were troubled with post-prandial diarrhea since having their gallbladder removed. Our first encounter with this in our obese patients was the one who had a very high cholesterol level, which caused us some concern for fear that the post-prandial diarrhea may become more severe after surgery. In this cohort of 440 patients, we have had 21 patients who had complained of post-prandial diarrhea after their gallbladder was removed; some of them were very severe. After the BPD with the duodenal switch, 18 patients (85%) said the post-prandial diarrhea was much improved and some claimed to be normal since surgery; three said that it was unchanged. Because of the results of

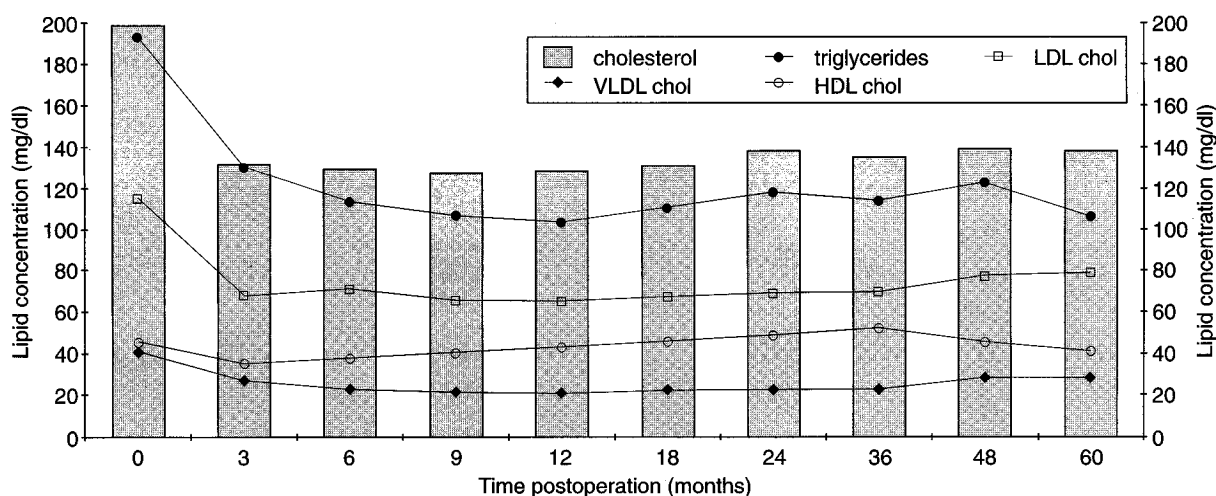


Figure 6. Lipid levels in the first 100 consecutive BPD with duodenal switch patients.

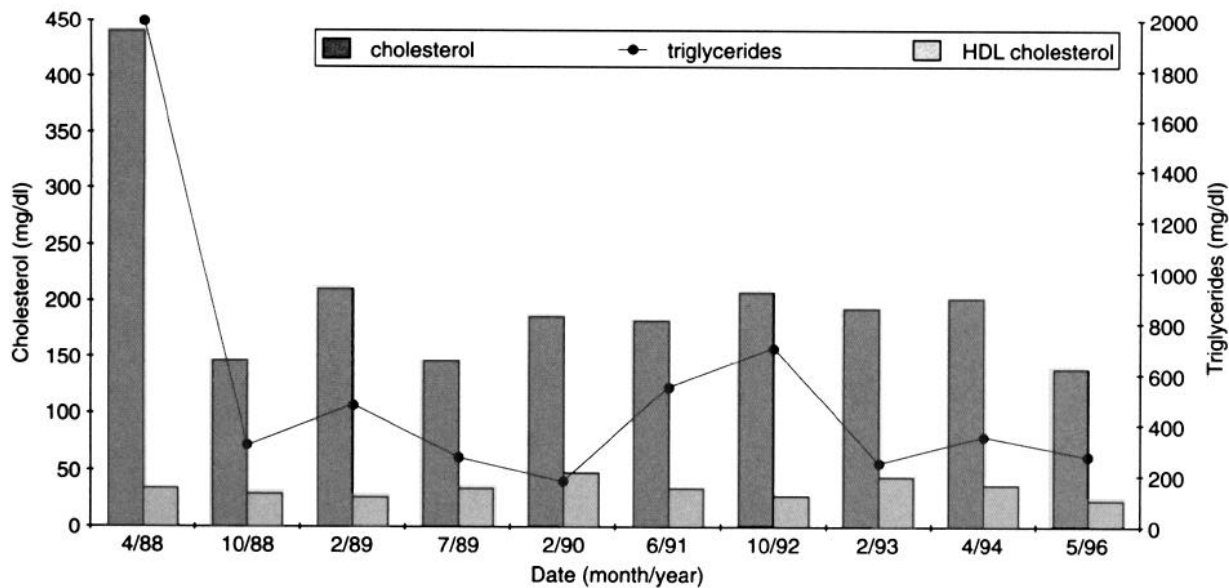


Figure 7. Lipid levels for patient No. 444.

the surgery on this particular patient problem we no longer believe that post-cholecystectomy post-prandial diarrhea is a relative contraindication to this surgery. In fact, obese patients who have the problem of post-cholecystectomy diarrhea would probably be markedly improved by a BPD with a duodenal switch procedure. Post-cholecystectomy post-prandial diarrhea could be considered as an additional indication for this surgery.

Diabetics

Bariatric surgery has been known to improve or cure diabetes mellitus.⁶ With the BPD and the duodenal switch we have operated on 36 diabetics, all type II, of which 18 were non insulin-dependent and 18 were insulin-dependent. One patient was taking as high as 500 U of insulin per day, but generally they were taking insulin in the range of 40–50 U per day. The non insulin-dependent patients would leave the hospital after surgery taking no medication and have continued taking no medication since their surgery. The insulin-dependent diabetics would occasionally take a small amount of insulin or a hypoglycemic agent for a short time, but never for more than 2 months following surgery. None of the above patients, after a few months and up to 7 years following surgery, are taking medication for any type of diabetes. All of them have normal blood sugars as indicated in the graph showing the

preoperative average blood sugar and the post-operative average blood sugar of all these patients up to 5 years (Figure 8). The present glycosylated hemoglobin average for this group is 5.0% (normal reference range is 4.2–5.9%). We can say without hesitation that for the obese type II diabetic, this surgery will cure their diabetes.

Anemia

It is well known that bypassing part of the lower stomach or part of the duodenum and proximal jejunum, raises the probability of developing anemia secondary to poor absorption of iron. Brolin, at the 1997 meeting in Chicago,⁷ reported a study of gastric bypasses with anemia in 48% of them. An anemic was defined as any patient whose hemoglobin or hematocrit came back lower than the laboratory's normal range. Using that criteria we would expect to have similar results in our laboratory studies. However, our averages of hemoglobin in our first 100 patients at random intervals of 3 months, 6 months and 1 year up to five years showed values of 12–13 g. There were 259 counts, of which 20 (7.7%) were below 10.5 g and of these there were 12 (4%) below 10.0 g with the lowest value at 6.4 g. We consider anemia requiring treatment to be a hemoglobin count of 10.5 or lower. When we evaluate our entire series of 440 patients we find 40 patients (9%) who required iron in some form or another. Of these

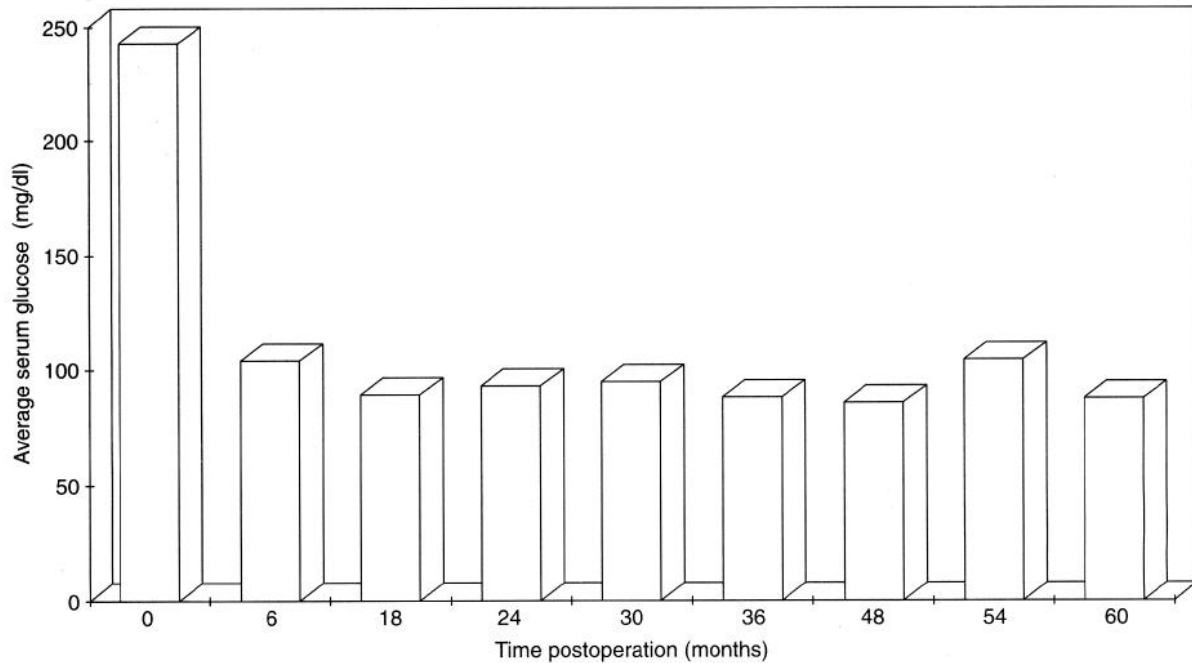


Figure 8. Glucose levels of diabetics.

patients who had low hemoglobin, seven had excessive uterine bleeding and required abdominal hysterectomies, and 10 patients had relatively severe anemia requiring intramuscular iron to correct. All anemias were correctable with the appropriate iron or surgical therapy.

Calcium

Serum calcium is very important in patients with a malabsorption procedure. The graph of the laboratory work of our first 100 consecutive patients (Figure 9) shows that the calcium level

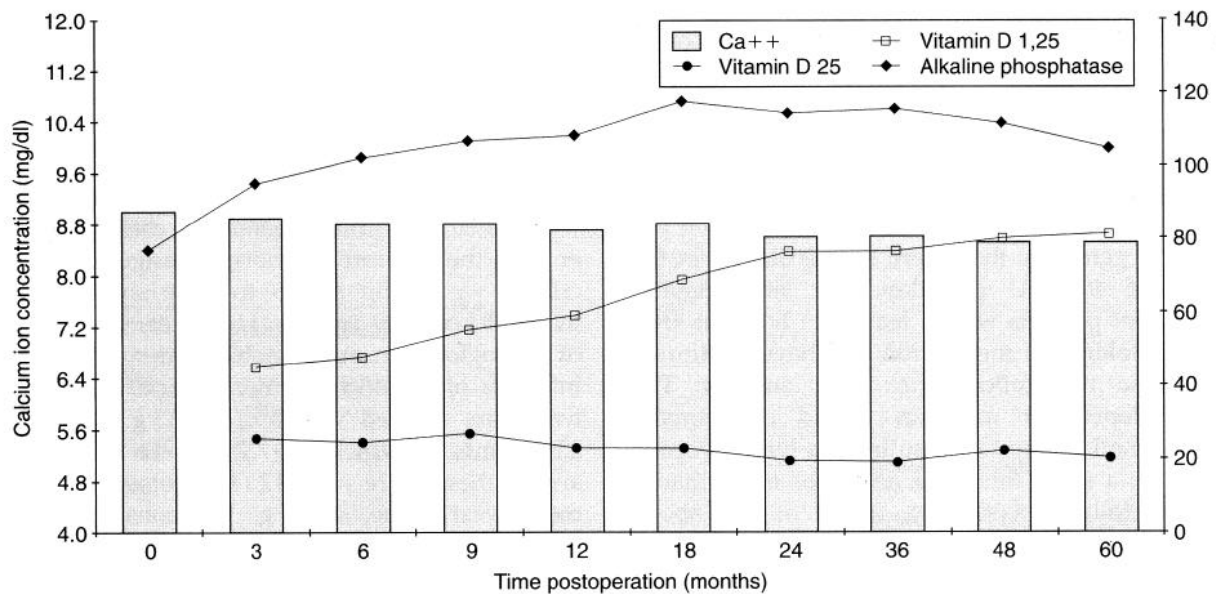


Figure 9. Calcium metabolism in the first 100 consecutive BPD with duodenal switch patients.

stayed relatively level and slightly below normal (659 counts in 5 years, range 7–10.8 mg/dl). The alkaline phosphatase is elevated indicating increased calcium or bone activity, possibly due to low calcium and vitamin D intake. The vitamin D-25 level is within the normal range, although it is on the low side. The vitamin D-1,25 level increases, as the 1,25 form of vitamin D is the active form in the mobilization of calcium from the bone to the serum. This graph is an indicator of the importance of adequate vitamin D and calcium supplementation.

Jarocho showed, in his poster presentation at the American College of Surgeons meeting in Chicago in 1997, that 31% of preoperative patients had levels of 25-hydroxy vitamin D of 30 or above (range 16–55) compared with 59% in the post-operative period at the end of 1 year.⁸ These results indicate that if the patients take vitamin D and calcium they can maintain the correct levels and in some cases increase their calcium and vitamin D to levels higher than those before surgery. Alkaline phosphatase is a good indicator of adequate intake of calcium and vitamin D.

Advantages

There are several advantages to the BPD with a duodenal switch. There is no isolated stomach and, no foreign body or band required. There is preservation of the pylorus, no dumping syndrome, no marginal ulcers, and good weight loss.

This operation is both a restrictive and a malabsorption procedure. However, neither of these procedures are performed to an extreme degree. The restriction is related only to reducing the size of the stomach. There is no constricting band or narrowed stoma. We use a vertical gastrectomy which preserves the pylorus, a portion of the antrum, some of the mid and upper stomach, and removes most of the acid-producing fundus. If, in the future, any revision needs to be performed on these patients it would be unusual to have to re-operate on the stomach. Second surgery in this area becomes difficult due to adhesions between the stomach, liver, and the upper abdominal area.

The malabsorption portion of this operation consists of an alimentary canal of 250–350 cm, with a common channel portion measuring 50–100 cm of the distal ileum, which nearly always gives adequate absorption and nutrition. If there

is some difficulty with malabsorption, the length of the alimentary canal and common channel can be extended without much difficulty and without disturbing the stomach or the duodenal anastomosis. Liver failure, renal failure, severe electrolyte imbalances etc. do not seem to be a problem with this operation, if the patients have adequate follow-up and proper supplementation.

Because the pylorus is still intact a functional reversal of this operation can be performed quite satisfactorily. The volume of the stomach, 100–175 ml, will enlarge with time, and is always adequate in size. Shortening of the Roux-en-Y or anatomical reversal would work without the formation of an ulcer or the need for vagotomy.

It is known that the gastric bypass with both a short or long limb Roux-en-Y may be an ulcerogenic operation. By the addition of the duodenal switch procedure the possibility of a marginal ulcer is remote.⁹ We had no marginal ulcers since using the duodenal switch procedure; this includes our redo surgeries giving a total of more than 600 procedures. Because we do not remove the pylorus and do not have marginal ulcers there is little need for a vagotomy, and in turn, there is no dumping syndrome. We have never had a dumping syndrome in any of our cases.

In our 20 years of experience, the BPD with a duodenal switch has been the most effective weight loss procedure, for both the morbidly obese and the super morbidly obese patient. For the super morbidly obese patient, restrictive procedures alone will probably not be successful. The BPD with a duodenal switch, however, is a procedure that has been shown to be a successful method of treatment for the super obese patient.

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