

Laparoscopic Biliopancreatic Diversion with Duodenal Switch: Three Different Duodeno-ileal Anastomotic Techniques and Initial Experience

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Background: The duodenal switch (DS) is a variant of the biliopancreatic diversion (BPD) for surgical treatment of morbid obesity. Absence of dumping syndrome leads to a high quality of life in these patients. The complexity of the laparoscopic BPD-DS is high, and the technical aspects of the duodeno-ileostomy are still under consideration.

Materials and Methods: Laparoscopic BPD-DS is described, with early surgical outcomes of 63 patients reported. We used 3 different techniques for creation of the duodeno-ileostomy, which were compared.

Results: 2 staple-line leaks at the gastric sleeve and 1 anastomotic leak after circular stapling of the duodeno-ileostomy occurred. In the same patient with the leak, a marginal ulcer was registered 4 months after surgery. There were no differences in the operating-time between the 3 groups. The combined linear stapled and totally hand-sewn anastomosis were the safest methods to perform the duodeno-ileostomy. Local wound infection at a trocar site (insertion of the circular stapler) was the most common local complication, occurring in 3 patients after using the circular stapling technique only. Postoperative stay was 4 to 8 days, except for the 3 patients with complications.

Conclusion: Laparoscopic BPD-DS is an advanced, complex and feasible technique in bariatric surgery. The combined linear stapled and total hand-sewn anastomosis are not only the technically easiest procedures to perform, but also appear to be the safest techniques.

Key words: Morbid obesity, bariatric surgery, biliopancreatic diversion, duodenal switch, laparoscopy, techniques of duodeno-ileostomy

Introduction

The duodenal switch (DS) is a well established technique for the surgical treatment of morbid obesity, as a modification of the hybrid or mixed Scopinaro biliopancreatic diversion (BPD).¹⁻⁶ This operation combines the early restriction of a pylorus-preserving vertical subtotal gastrectomy with the malabsorption of a BPD (exclusion of the first half of the small bowel, with a 100-cm common limb). Gagner in New York, performed the first laparoscopic duodenal switch in September 1999.^{7,8} In Europe, the first DS was performed by Baltasar in Spain.⁴⁻⁶ We studied Baltasar's technique and performed 3 different techniques to create the duodeno-ileostomy. We present our experience with laparoscopic DS, using 3 different techniques for creation of the duodeno-ileostomy.

Materials and Methods

Sixty-three morbidly obese patients underwent laparoscopic BPD-DS as a primary procedure for morbid obesity from March 2002 to June 2003 by a single surgeon (RAW). All patients were considered morbidly obese as classified by the NIH Consensus Conference,⁹ and had failed medical therapy for weight reduction. Body mass index (BMI) was >40 kg/m² in all patients. Complete information concerning risks and benefits of this surgical approach was given, and patients gave informed consent.

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Fifty-six of the patients were female and six male, with age 24 to 52 years, weight 122 to 237 kg, and BMI 40.7 to 71.8 kg/m². The patient characteristics are summarized in Table 1. For the different techniques for creating the duodeno-ileal anastomosis, we followed the patients in three groups. The circular stapled anastomosis (Gagner)^{7,8} was performed in group A, the combination of linear stapling and hand-sewn in group B, and the total hand-sewn anastomosis in group C.

Operative Technique

All patients were operated on with the following techniques. Antithrombotic prophylaxis was performed in all patients, consisting of applying lower limb elastic bandage, early postoperative mobilization (3 h), and administering subcutaneous heparin. At induction, 3 g cephalosporin I.V. was administered as antibiotic prophylaxis in a single dose.

The patient was placed supine, under general anesthesia, with the legs separated. We used a six-trocar approach. The camera trocar was placed in the left supraumbilical area. Another trocar at the right subcostal position (10-mm) allowed liver

retraction and access to the hiatus. Two trocars were placed in the epigastric region 10 cm to the left and 10 cm to the right of the mid-line (12-mm each). One trocar was placed at the left lateral border of the anterior rectus muscles above the umbilicus (right 15-mm, and a left 5-mm). For cholecystectomy, an additional 5-mm trocar was used in the right upper quadrant. All operations were video-documented. The operating-time of the different surgical steps were analyzed retrospectively by means of the video-documented time-sequences. The surgical steps were standardized in all operations, except for the three techniques of creating the duodeno-ileostomy (Table 2).

The greater curvature of the stomach and the first segment of the duodenum were devascularized with the harmonic scalpel. The duodenum was divided with a linear cutter. Injuries of the common bile duct must be avoided. The vertical subtotal gastrectomy (sleeve gastrectomy) commenced 6 cm proximal to the pylorus at the greater curvature by serial application of a series of linear cartridges parallel to the lesser curvature, using a nasogastric tube stent (40 Fr bougie). The rest of the stomach was divided with linear staplers serially to the cardia. Thus, a gastric tube was constructed based on the lesser curvature, and 70-80% of the stomach at the greater curvature was resected. The gastric remnant was filled with methylene blue to detect leaks. There was no attempt to measure the volume of the tube, although it could be done easily by clamping the proximal

Table 1. Patient characteristics including co-morbidity at time of surgery.

Gender	56 females 6 males	
Age	mean: 40.25 SD: 73, range 24-52 yrs.	
BMI	mean: 55.80 kg/m ² , SD: 8.73, range 40.7-71.8 kg/m ²	
Chronic venous incompetence	30 cases	(46.9%)
Chronic obstructive bronchopathy	19 cases	(29.7%)
Hyper-cholesterolemia/triglyceridemia	18 cases	(28.1%)
Arthropathies	16 cases	(25.0%)
Effort dyspnea	15 cases	(21.7%)
Hiatal hernia	15 cases	(21.7%)
Gastroesophageal reflux disease	12 cases	(18.8%)
Hypertension	12 cases	(18.8%)
Diabetes	10 cases	(15.6%)
Sleep apnea syndrome	10 cases	(15.6%)
Cholelithiasis	8 cases	(12.5%)
Ischemic or hypertensive cardiopathy	5 cases	(7.7%)

Table 2. Time-periods of laparoscopic DS

Steps	Surgical Procedure
1	creation of pneumoperitoneum, trocar placement, adhesiolysis
2	dissection of greater curvature, sleeve gastrectomy, oversuturing staple-line
3	dissection of duodenum, cutting the duodenum
4	cholecystectomy, operative cholangiography
5	appendectomy
6	measurement of bowel length, marking
7	entero-entero anastomosis
8	duodeno-ileostomy
9	removal of resected stomach, gallbladder, appendix
10	trocar-site and minilaparotomy closure
11	placement of drains and skin closure

and distal ends of the stomach while filling the tube. In two patients a leak in the staple-line (blue cartridges) in the antrum was detected, and oversuturing was necessary. The resected part of the stomach was removed by means of a bag through the 15-mm port or a suprasymphysial incision. Hemostasis of the suture-line was accomplished with a running suture of Vicryl®. In two patients, staple-line reinforcement was used, and no staple-line bleeding was seen.

In order to perform the duodeno-ileostomy, the surgical team moved cranial, and the TV-monitor was positioned to the patient's right. The common channel (CC) measurement started at the ileocecal junction without stretching the bowel. A suture was placed at 100 cm, indicating what was to become the CC. The bowel was divided with a linear cutter 250 cm proximal of the ileocecal valve to form the alimentary limb (AL). The mesentery was partly divided with the harmonic scalpel. The biliopancreatic limb (BPL) and AL were connected by a hand-sutured side-to-end anastomosis at the 75-cm (first 5 patients) and 100-cm mark, to prevent obstruction of the small bowel lumen caused by narrowing the small diameter.

The duodeno-ileostomy was performed by three different techniques, but in every case we used the antecolic route:

Group A: In 21 patients, the duodeno-ileal anastomosis was done by circular stapling with the Ethicon-21 (Ethicon Endo-Surgery). An antecolic end-to-side duodeno-ileostomy was created by passing the circular stapler transabdominally, advancing it into the lumen of the lower ileal segment, and attaching it to the anvil residing in the gastroduodenal pouch. A plastic camera drape secured around the circular stapler acted as a wound protector during removal of the contaminated device.

Group B: In 21 patients, the side-to-side anastomosis was performed by linear stapling of the backside and hand-suturing of the front-side by a single layer of running Vicryl®. First, stay-sutures were placed at the ends of the duodenum and the efferent loop. After opening the intestinal lumen at the edges, a linear stapler (white cartridges) was introduced and fired. The opening of the intestine was closed by running sutures.

Group C: The third technique was the complete hand-sewn anastomosis (21 patients), as we learned from Baltasar.⁶ The duodeno-ileal end-to-side anastomosis was hand-sutured by a continuous suture of 2-0 polypropylene. After suturing the backside, a naso-transgastric tube was placed into the efferent loop. Thereafter, the front-side was sutured by a running suture with 2-0 polypropylene. In every case we also inserted stay-sutures (Vicryl®).

The mesenteric defects were left open during the first 42 operations. Thereafter, we closed the Peterman space by single stitches of silk. Suture-lines were checked for bleeding, and intraluminal irrigation was done with methylene blue to detect any leaks. Additional cholecystectomies were performed in 42 patients (in 21 patients the gallbladder had been previously removed). In only 12 patients were there pathological findings in the gallbladder.

Forty-nine additional appendectomies were performed. Two soft closed-suction drains were placed and brought out through port sites; one was placed over the proximal anastomosis and duodenal stump, and one over the distal anastomosis. Fascial closure of all trocar sites >12 mm was accomplished with a suture-passing device. The use of Versastep®-trocars (US Surgical Corp) produced small fascial defects. All patients received appropriate dietary indications, either hyperproteic with vitamin supplement or fluid hypocaloric according to the surgical procedure adopted. No particular restriction of standard physical activity was imposed.

Results

The mean duration of all surgical interventions was 207 minutes (Figure 1). Operative times (skin-to-skin) ranged from 110 to 280 minutes. There was a markable learning curve. The mean operating-times for each of the three duodeno-ileal anastomosis techniques analyzed by video-documentation are shown in Table 3 and Figure 2. The time for establishing the duodeno-ileostomy and the different surgical steps are shown in Figure 1. In 4 cases, the placement of the anvil into the duodenum was difficult and led to a statistically significant prolonged operating-time in group A (Table 3). All operations were completed by laparoscopy with no need for

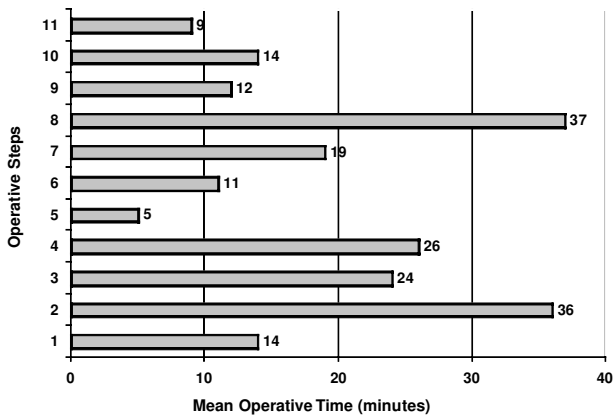


Figure 1. The mean operating-times for the different surgical steps are shown (total 207 minutes).

conversion. The harmonic scalpel was indispensable for safe execution of the operation. One postoperative leak was seen in group A (2nd postoperative day). The leak with diameter 2 mm was caused by open staples at the lesser curvature side (possibly too much tension). The leak was closed by laparoscopic oversuturing. Generally, the use of the circular stapling device led to a loss of tissue, so that the anastomosis was closer to the pylorus.

All patients were admitted to the Intensive Care Unit for less than 16 hours. All patients had a nasogastric tube for 48 hours, excepted for one patient who had removed the tube immediately postoperatively. The mean hospital stay was 6.5 days. One patient had significant intraoperative bleeding from the sleeve gastrectomy at the gastric division suture-line that required transfusion of 5 units of packed red cells.

An upper GI Gastrografin® swallow was done in 25 patients after 24 hours and in 37 patients after 48 hours (Figure 2), and liquids were allowed. Of

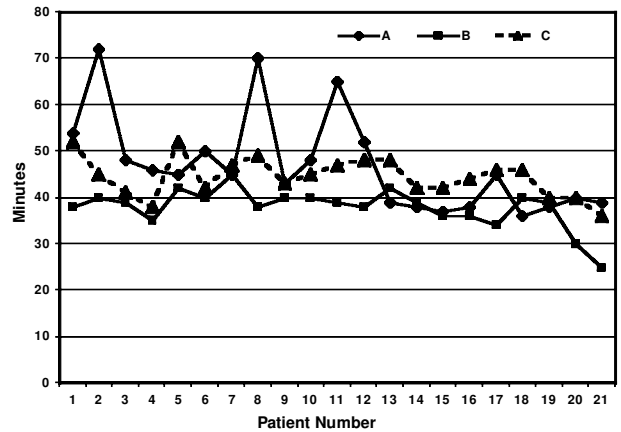


Figure 2. Time involved to perform the duodeno-ileal anastomosis in groups A, B and C.

these, 62 postoperative upper GI studies were negative, with no evidence of leak at the proximal anastomosis. Only one patient developed partial stenosis of the gastric tube, and was treated by nasogastric intubation for 2 days. This patient had removed the nasogastric tube immediately after surgery. Three patients developed four major complications (5.8%) (Table 4). Despite a negative Gastrografin® study, there was one anastomotic leak and two staple-line leaks. The leaks were detected 3 days postoperatively because of suspicious drainage from a drain-site. These three patients required reoperations which were performed by laparoscopy and one was converted to a laparotomy.

There were no problems at the entero-enterostomy site. Three additional patients developed staple-line hemorrhage. They were treated conservatively without blood transfusion and had an unremarkable course thereafter.

Patients were discharged 4 to 8 days postoperatively, except for the three patients with major com-

Table 3. Differences in the operating-time to perform the duodeno-ileal anastomosis (minutes)

group	n	mean	SD	minimum	25% CDI	median	75% CDI	maximum
A	21	46.70	10.72	36.00	38.50	45.00	49.00	72.00
B	21	37.33	4.91	25.00	36.00	39.00	40.00	45.00
C	21	44.05	3.99	36.00	41.50	44.50	47.00	52.00

Kruskal-Wallis test: significant differences between the 3 groups ($P=0.0002$). In relation of pair-groups, A and B ($P=0.0028$) and differences between B and C ($P<0.0001$). There was no statistical difference between group A and C ($P=1.000$).

plications. Three patients developed local wound infection at the site where the circular stapler had been used, and these wounds had secondary closure. An additional two patients after the revisional surgery developed a wound infection, so that the total incidence of wound infection was 10%. Minor infections occurred in two patients (3.8%) involving the urinary and respiratory tract. Patients had no more postoperative pain than following regular laparoscopic operations.

Follow-up was at 1, 3, 6 and 12 months after surgery, and then at 1-year intervals. To date we have not observed long-term proctologic complications. Data regarding weight loss, improvement of comorbidities, metabolic changes, and quality of life will be published at a later date.

An emergency intervention was necessary at 8 months after the DS due to acute incarceration of the ileo-ileostomy in a pre-existing umbilical hernia. Gastric anastomotic ulceration occurred in one patient (1.9%) 5 months after surgery, and was successfully managed by medical therapy.

The most common complication was incisional hernia, which occurred in 4 patients. The hernias were located at the trocar site. Twelve female patients at various time-periods following DS, underwent plastic surgery for persistence of the abdominal apron. Eight patients required rehospitalization for various reasons. The number of hospital admissions per patient varied between 1 and 3.

During follow-up, significant improvement was observed for patients affected by lower limb chronic venous incompetence (95% of cases). In 90% of cases, hypertensive patients were able to stop medical therapy or reduce drug dosage. Serum lipid levels normalized by 1 year in 100% of patients. All diabetic patients stopped insulin at 1 year, and only 21% remained on oral antidiabetic medication. All patients reported an increase in physical activity,

either because of an improvement in osteoarthropathy or in cardiorespiratory performance.

Discussion

Laparoscopic bariatric surgery has developed over 10 years, as the operations themselves have altered.¹¹ Brolin criticized the criteria that led the NIH in 1991 to support the routine use of vertical banded gastroplasty and gastric bypass,^{9,12} stressing the long-term weight loss obtained with these operations, and asked for an assessment of the use of BPD and laparoscopic techniques. Thus far, consensus has not been reached by the scientific community regarding the choice of surgical intervention. Bariatric surgery is in continuous evolution. Simple techniques such as the adjustable gastric bands are popular in Europe, Australia and Mexico.¹³ We abandoned the vertical banded gastroplasty because of poor long-term results.¹⁴⁻¹⁶

Complex procedures such as open or laparoscopic gastric bypasses are most frequently performed in the U.S.A. The hybrid, mixed techniques are common in Italy and Spain;¹⁷ the DS is a variation of it and is becoming increasingly popular because of its excellent weight loss and quality of life. The BPD provides the most effective weight loss of any operation thus far, with mean maintained excess weight loss about 80%.¹⁷⁻¹⁹ However, BPD is a procedure of some magnitude. The BPD was modified by Marceau's group with the duodenal switch,²⁰⁻²² which is now performed in a number of other centers.^{2,23-25} The greater curvature portion of the stomach is resected (leaving a tube), and the proximal duodenum is divided. At the point of division of the ileum the distal end is anastomosed to the proximal duodenum, and the proximal end is anastomosed to

Table 4. Complications after laparoscopic BPD-DS

Group	n	leakage	stenosis	ulcer	wound infection	hernia
A	21	1	0	1	3*	2*
B	21	0	0	0	0	0
C	21	0	0	0	0	0

*Severe postoperative wound infection after circular-stapling, with the hernia following.

the side of the distal ileum.²¹ Concerning BPD, Scopinaro et al^{17,18} reported a 15-year follow-up with >70% excess weight loss. Other authors with a shorter follow-up of 5²⁶⁻²⁸ and 2 years¹⁹ reported similar results.

Most of our early complications were related to our early experience, in particular the cases of postoperative gastric bleeding, which were due to incomplete hemostasis on the gastrointestinal stapled anastomotic line. Thromboembolic complications are the most common cause of mortality in bariatric surgery.²⁹ Recently, an increase in fibrin synthesis, interaction between fibrin and platelets, and platelet activity have been demonstrated during the postoperative period in morbidly obese patients versus non-obese control patients.³⁰

In the lap DS, devascularization of the greater curvature of the stomach can be done safely with the harmonic scalpel. Bleeding of the divided stomach can be controlled by Peri-Strips Dry[®] (Synovis, St. Paul, MN, USA)³¹ or by sutures used sequentially after each stapler firing. This bleeding can be extensive, as reported by Ren et al,⁸ who required blood transfusion in 10% of their patients, and there is some doubt regarding the use of prophylactic heparin with this technique.

The duodeno-ileal anastomosis can be done by different techniques. The use of circular staplers had some problems. Passing the anvil through the mouth with the Ethicon-21 stapler was somewhat cumbersome, because the diameter of the anvil made the manoeuvre difficult. By using the flipping Tyco-25 anvil (US Surgical), the anvil passes more easily.^{7,8} The problem remains of passing the nasogastric tube through the pylorus, which may take a long time to manoeuvre. The combined technique of linear stapling and hand-sewn anastomosis is another option. By using the hand-suturing technique of Baltasar,^{6,23} technical problems with placement and positioning of staplers are resolved. Also, passage of the circular-stapler through the abdominal wall increases the possibility of wound infection at the trocar site. Also, a higher incidence of incisional hernias occurred when circular staplers had been used.

In our early experience, the laparoscopic BPD-DS has proven to be feasible with successful completion in 63 patients. The major morbidity in our series (10%) is comparable to that of other bariatric

operations. The anastomotic leak rate of 1.9% is comparable to the open BPD-DS series with ranges of 2-5%.³³ The combined linear-stapled and hand-sewn anastomosis are safe techniques for the duodeno-ileal anastomosis, which are not more time-consuming than the use of circular stapling devices.

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