Laparoscopic Biliopancreatic Diversion with Duodenal Switch - The Most Effective Operation for Type 2 Diabetes Mellitus. How I do it?

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Abbreviations:

BPD-DS -Biliopancreatic diversion with duodenal switch;
T2DM - Type 2 Diabetes Mellitus;
LBPD-DS -Laparoscopic Biliopancreatic Diversion with Duodenal Switc
GB - gastric banding;
GS - gastric sleeve resection;
VBG - vertical banded gastroplasty;
BPL - biliopancreatic limb;
TL - total length;
DS - duodenal switch;
SSO - super-super obese

Rezumat

Diversia biliopancreatică cu duodenal switch - cea mai eficientă operație pentru diabetul zaharat de tip 2 - tehnica laparoscopică

Background: Obezitatea morbidă și diabetul de tip 2 se extind rapid în întreaga lume, iar tratamentul conservator oferă un control limitat, în timp ce chirurgia metabolică, mai eficientă, este tot mai des mai recomandată. Diversia biliopancreatică cu duodenal switch (BPD-DS) este o operație care și-a demonstrat eficiența metabolică și superioritatea față de alte proceduri bariatrice. Obiectivul articolului este de a descrie tehnica laparoscopică pentru BPD-DS.

Metode: Tehnica operatorie a BPD-DS este prezentată în detaliu. Au fost analizați 56 de pacienți consecutivi la care s-a efectuat BPD-DS laparoscopic, reprezentând 0.7% dintre pacienții operați de autor între 2002 și 2018. Treisprezece dintre aceștia au beneficiat de BPD-DS ca primă intenție, iar pentru restul (42 de pacienți, 75%) BPD-DS s-a efectuat în două etape. 48 de pacienți au avut T2DM slab controlat terapeutic. Durata medie de spitalizare a fost de 6 zile (3-21). Mortalitatea la 30 de zile a fost zero. Complicații majore au apărut la 4 pacienți (7,1%), incluzând 1 fistula anastomotică (1,7%) și 3 hemoragii (5,3%); 12 pacienți BPD-DS au fost pierduți în programul de urmărire iar durata medie de urmărire a fost de 62 de luni (12-156 luni). Pierderea % excesului de BMI a fost de $82 \pm 13\%$, în timp ce rata de remisiune T2DM a fost de 92% (44pts).

Concluzie: Dovezile actuale sugerează că BPD-DS este cea mai eficientă procedură metabolică pentru comorbiditățile asociate obezității, în special pe T2DM, cu o acceptabilă de complicații peri-

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operatorii. Cu toate acestea, datorită complexității sale tehnice și a riscului de instalare a unor tulburări metabolice severe sau malnutriție, utilizarea acestei proceduri chirurgicale bariatrice este limitată în comparație cu alte opțiuni chirurgicale.

Cuvinte cheie: duodenal switch, laparoscopie, chirurgie metabolică, obezitate morbidă, diabet zaharat tip 2

Abstract

Background: Morbid obesity and type 2 diabetes are rapidly increasing worldwide. The conservative treatment is providing a limited control while the more efficient metabolic surgery is more recommended. Biliopancreatic diversion with duodenal switch (BPD-DS) is the operation which provides one of the most stable weight losses and T2DM remission of any bariatric procedure. The aim is to describe the technique of laparoscopic BPD-DS.

Methods: The detailed technical aspects of LBPD-DS are presented. Fiftysix consecutive patients underwent laparoscopic BPD-DS in our Bariatric Surgery Program, meaning 0.7% of the authors' bariatric surgery activity (2002-2018). Thirteen of them had BPD-DS as a primary option and the rest (42 patients, 75%) had the procedure in 2 stages. 48 patients had poorly controlled T2DM. Median hospital length of stay was 6 days (range 3-21 days). There 30-day mortality was nil. Major morbidities occurred in 4 patients (7.1%), including 1 anastomotic leak (1.7%), 3 staple-line hemorrhages (5.3%) 12 BPD-DS patients were lost in the follow-up program and the mean follow up rate for the rest was 62 months (12-156 mo.). The %excess BMI loss was $82 \pm 13\%$ while the T2DM remission rate was 92% (44 pts)

Conclusion: Current evidence suggests that BPD-DS is the most effective metabolic procedure on obesity-related comorbidities, especially on T2DM, with an acceptable morbidity. However, due to its technical complexity and concerns regarding severe metabolic disturbances and malnutrition the utilization of this bariatric surgical procedure is limited compared to other surgical options.

Key words: duodenal switch, laparoscopy, metabolic surgery, morbid obesity, type 2 diabetes mellitus

Introduction

Obesity is a complex multisystem condition, associated with increased comorbidities including type two diabetes (T2DM), dyslipidemia, hypertension, obstructive sleep apnea, heart disease, stroke, asthma, bone and joint problems, cancer, and depression (1). Type 2 diabetes (T2DM) is the most common form of diabetes, leads to many health problems including cardiovascular disease, stroke, blindness, kidney failure, neuropathy, amputations, impotency, depression, cognitive decline and mortality risk from certain forms of cancer and its prevalence throughout the world has been in direct association increase rates of obesity worldwide (2).

Current therapy for type 2 diabetes includes lifestyle intervention (weight-loss, appropriate diet, exercise), anti-diabetes medication(s) or metabolic surgery (3).

The Biliopancreatic Diversion (BPD), one of the bariatric surgery procedures, consisting of distal gastrectomy and a gastro-ileostomy, with a 3 meters alimentary limb and a 50 cm common channel has demonstrated important metabolic benefits in morbidly obese patients (4) but the indications remained limited due to some associated complications and micronutrient deficiencies (5). The addition of the duodenal switch (DS)(6) and the introduction of the minimal invasive approach in 1999 (7) reduced significantly these complications (8).

Today, Biliopancreatic Diversion with duo-

denal switch (BPD-DS) is known as the most efficient metabolic procedure, providing a very good and sustained control of the Type 2 Diabetes mellitus (8,9). However, the procedure (Fig. 1) is a very complex one and it requires careful postoperative management, including life-time follow-up and supplementation.

The aim of this article is to describe the technique of Laparoscopic Biliopancreatic Diversion with Duodenal Switch (LBPD-DS).

Method

Indications & Contraindications

The morbidly obese patients who have attempted unsuccessful conservative weight loss treatment attempts are considered candidates for Laparoscopic BPD-DS. This procedure is also very effective on Type II diabetes mellitus, severe dyslipidemia and as a redo procedure after failure of the restrictive procedures like: gastric banding (GB), gastric sleeve (GS) or vertical banded gastroplasty (VBG). Absolute contraindications include vegetarian patients and those having inflammatory bowel disease (IBD). The patients who have bowel shortenings resulting in uncontrollable diarrhea or patients with proteinuria are also considered contraindications for BPD_DS (these conditions may severely influence the protein balance) (10).

Preoperative Evaluation and Work-up

The preoperative evaluation, should search for any condition that must be treated prior to surgery. The blood tests, the cardiologic and pulmonary evaluation, an upper GI contrast study and an esophago-gastro-duodenoscopy, the evaluation by a psychiatrist and by a nutritionist are routinely performed. Colonoscopy is indicated in those patients presenting abnormalities in large bowel function or signs of IBD. All the patients are evaluated by the anesthetist, especially for difficult airways in order to identify, prevent or avoid any potential risk of complications.

Figure 1. Scheme of the BPD-DS . Gastric Sleeve Reservoir of 150 ml, Alimentary Channel of 250 cm and Common Channel of 100 cm

Operating Room and Patient Set-up

The laparoscopic BPD-DS is performed under general anesthesia and endotracheal intubation. The patient is placed in French position and a proper fixation on the operating table is essential to avoid any postural complications. An HD camera and a 10 mm 30 or 45° long laparoscope are strongly recommended. The image will be displayed on two monitors able to rotate around the patient, easy accessible to the entire surgical team. A Cuschieri liver retractor and long laparoscopic instruments are necessary for most of the patients.

Surgical Technique

The laparoscopic approach for BPD-DS includes the following steps: division of the duodenum, sleeve gastrectomy, approximation of the alimentary limb and of the common channel followed by the creation of duodenoentero-

stomy and a distal ileoenteric anastomosis. Routine appendectomy is not always necessary and laparoscopic cholecystectomy is performed when cholecystitis is present.

Pneumoperitoneum is set to maximum 15 mmHg, reducing the hemodynamic impact of the intra-abdominal gas pressure. Seven ports are routinely inserted for the laparoscopic BPD-DS procedure.

Long trocars are sometimes needed in patients who have a very thick abdominal wall. The standard position of the trocars is presented in *Fig. 2*. Three 10 mm and one of 5mm reusable trocars, and three disposable 12 mm ports are inserted. Additional disposable or reusable trocars are used according to the individual needs of the patient.

For Gastric Sleeve Resection, the surgeon stands between the patient's legs. A 10 mm Cuschieri liver retractor is introduced through a 10 mm Ternamian epigastric port to lift the left lobe of the liver and to expose the anterior aspect of the stomach. The gastric resection begins by dissecting the greater curvature starting at the level of gastric angle, where getting into the lesser sac is very facile. The gastric vessels are divided with a laparoscopic sealing/divider instrument (LigaSure, Metronic, US.) or an ultrasonic dissector (Harmonic-ACE, Ethicon, US). Distally, the dissection continues on duodenum and it ends 2 cm from the pylorus. At this point, a retro-duodenal tunnel is created by

gentle dissection maneuvers starting from the inferior duodenal margin (*Fig. 3*). The dissection is continued very close to the posterior wall of the duodenum, in a plane superior to the gastroduodenal artery (which is often seen posterior) (*Fig. 4*). A supra-duodenal window left-siding the hepatic pedicle is created. The small arterial branches at the superior margin of the duodenum are preserved. The duodenum is divided with a 60-3.5 linear stapler which passes gently along the justcreated retro-duodenal route. Injury to the pancreas, the duodenum, the gastroepiploic or the gastroduodenal arteries have to be avoided (*Fig. 5*). The LSG is initiated at 4-6 cm proximal to the pylorus, by firing a black or green linear stapler inserted through the right sided 12 mm disposable port as described (11). Next, a 56 French bougie inserted orally by the anesthesiologist is passed into the distal antrum. The LSG is completed by firing other 60 mm linear staplers, inserted through the left sided 12 mm disposable port (*Fig. 3*). The stapled line is oriented parallel left-siding the calibration bougie. Oversewing or haemostatic clips are used to control the stapled line bleeding. The calibration bougie is removed and the resected stomach is extracted in an endobag, usually after enlarging one of the access ports.

The entire small intestine is measured starting from the ileocecal valve. A 100 cm common channel is approximated from the

Figure 2. Laparoscopic BPD-DS Port Position Scheme

Figure 3. Biliopancreatic Diversion with Duodenal Switch (BPD-DS) - Laparoscopic Duodenal Dissection and Stapling

Figure 4. Laparoscopic BPD-DS – duodenal dissection

Figure 5. Aspect after division of the duodenum 2 cm away from the pylorus

ileo-cecal valve and its proximal end is marked with a colored stitch. Another 150cm are proximally measured and, at this point, the cranial end of the alimentary channel is marked with a different color stitch. The small bowel evaluation continues up to the angle of Treitz and the length of the biliopancreatic limb (BPL) and of the entire intestine is noted. This information is important to appreciate a formula for each patient. Hess et al. (6) demonstrated that the total length (TL) of the small bowel vary from 4 to 10 m and only a combination of 40% of TL for the alimentary channel with 10% for the common channel provides good long-term results and less complications (6). In most of the cases 100 cm for CC and 250 cm for AL is an appropriate formula. Next, at the proximal end of the AL, the ileum is transected with a 60-2.5 linear stapler. The distal end of the transected ileum will be moved up to the duodenum to create the duodeno-ileal anastomosis, while the proximal ileal end is anastomosed with distal intestine to form the common channel (CC). Note that the BPL is coming from the left side of the abdomen while the AL and CC are on the right side of the patient (10).

In order to perform the duodeno-ileal anastomosis, depending on the mesentery mobility, an ante-colic or a trans-mesocolic route of the enteral limb is considered. In most of the cases, we prefer the antecolic end-to-side duodeno-enterostomy. For LBPD-DS, the duodenoileal anastomosis can be fashioned in several ways: with a circular or a linear stapler or manually, the last being our

preferred option. The end-to site hand sewn duodeno-enterostomy is fashioned in two layers.

The posterior layer is realized with 2.0 resorbable running suture, incorporates the staple line and ensures the apposition of the two anastomotic partners. Enterotomies are then performed with the help of Harmonic shears or monopolar hook on the duodenum and ileum sites, respectively. The second posterior layer is a 2.0 resorbable monofilament running suture. Next, two anterior 2.0 running sutures will close the anastomosis (Fig. 6). The use of Robotic assisted surgery for this anastomosis facilitates the suture technique (12).

Finally, a naso-gastro-duodenal tube will be placed and a methylene blue test is performed. The capacity of the tubular stomach is approximated by the volume of methylene blue introduced to distend it and it usually is 150 ml.

The proximal end of the transected ileum (the biliopancreatic limb) is anastomosed to the

Figure 6. Laparoscopic BPD-DS - duodeno-ileal anastomosis

distal ileum, at 75 or 100 cm proximal to the ileocecal valve, to form the common channel. This ileoileostomy is performed in a standard site-to-side fashion with a 60-2.5 linear stapler. Small enterotomies are done on the antimesenteric borders of the two intestinal loops. Each jaw of the linear stapler is inserted into an enterotomy and the instrument is fired (*Fig. 7*). The opening is closed with a 2.0 running suture.

All the mesenteric defects, at the ileo-ileostomy and the Petersen's space should be closed with 2.0 non-resorbable running suture (*Fig. 8*). Before the end of the procedure, the gastric tube, the two anastomoses are once again inspected, a search for all the bleeding sources is done, the orientation of the limbs is verified. Next, two suction drains are placed: one near to the proximal anastomosis and duodenal stump, and one in Douglas' pouch.

Postoperative Care

In the first postoperative day (POD 1), patients receive only clear liquids diet. An upper gastrointestinal study with water-soluble contrast (Gastrografin®) is routinely performed on the second postoperative day (POD-2) in all patients, to evaluate and document the shape, capacity and function of the stomach. For the next 3 weeks a protein-enriched diet is recommended. A CT-scan will be considered at any time a complication is suspected.

The preoperative medication for patient's comorbidities is continued and later adjusted according to the patient's needs. Painkillers are necessary for the first postoperative days. Proton pump inhibitors (PPIs) and low molecular heparin (LMWH) are administrated for minimum 3 weeks. All the drainage tubes are usually removed in POD1. The follow-up appointments are scheduled for 30 days, 3 months, 6 months, 12 months and annually after. All patients receive life time nutritional counseling.

Protein-enriched diet and daily multi-vitamins, oral supplements (calcium, iron and fat-soluble vitamins – A,D,E,K) are recommended. The gallstone prophylaxis is initiated

Figure 7. Laparoscopic BPD-DS - site-to-site ileal anastomosis

Figure 8. Laparoscopic BPD-DS - mesenteric gaps closure

in the patients with intact gallbladders (500 mg/day of Ursodeoxicolic acid).

Extended laboratory evaluation for nutritional or protein deficiencies is performed at each visit beginning with 3 months. An upper GI Endoscopy is performed at every 6 months or any time needed (ex. altered food tolerance).

56 consecutive patients underwent laparoscopic BPD-DS in our Bariatric Surgery Program, meaning less than 1% of the author bariatric surgery activity (2002-2018). Thirteen of them had BPD-DS as a primary option and the rest (42 patients, 75%) had the procedure in 2 stages. 48 patients had uncontrolled or poorly controlled T2DM. Median hospital length of stay was 6 days (range 3-21 days). The 30-day mortality was nil. Major morbidities occurred in 4 patients (7.1%), including 1 anastomotic leak (1.7%), 3 staple-line hemorrhages (5.3%) 12 BPD-DS patients were lost in the follow-up program and the mean follow up rate for the rest was 62 months (12-156 mo). The % excess BMI loss was $82 \pm 13\%$ while the T2DM remission rate was 92% (44 pts).

Discussion

Morbid obesity and type 2 diabetes are rapidly increasing while the conservative treatment including lifestyle intervention (weight-loss, appropriate diet, exercise), weight loss or anti-diabetes medication(s) are providing a limited control. In this scenario, the more efficient metabolic surgery (3) is more recommended.

The concept of Biliopancreatic Diversion (BPD) was described by Nicola Scopinaro in 1979 as an alternative to jejunoileal bypass for severely obese patients. BPD is consisting of distal gastrectomy and a gastroileostomy, thus creating a 3 meters alimentary limb and a biliopancreatic limb anastomosed with the alimentary limb 50 cm before the ileocecal valve forming a common channel (4). The metabolic benefits of the BPD procedure were demonstrated in time, weight loss being followed by a substantial reduction in the co-morbidities that are present in morbidly obese patients (13). However, the indications remained limited due to some associated complications including marginal ulceration, vomiting, diarrhea, dumping syndrome, and micronutrient deficiencies (5).

The addition of the duodenal switch (DS) in which a vertical sleeve gastrectomy is combined with a duodenoenterostomy, was proposed in 1988 by Hess and Marceau (6), and it was named the "second generation BPD" (3) or Biliopancreatic Diversion with Duodenal Switch (BPD-DS).

BPD-DS involves preservation of the lesser curvature, antrum, pylorus, and first part of the duodenum along with lengthening of common channel lengths from 50 cm to 100 cm or more. These modifications were created to control for complications associated with Scopinaro's original description (8).

The technique of BPD-DS consisting of a pylorus-preserving gastric sleeve resection with a duodenal switch has been shown to have the best results of any metabolic procedure, including Roux en Y Gastric Bypass, (14) in terms of efficiency and duration of weight loss (3) (*Fig. 1*). The resolution of T2DM has been demonstrated in 90-100% of the cases (9,

15-18). However, the procedure is a complex one associating high peri-operative morbidity, especially in the super-super obese (SSO) patients. Michel Gagner performed the first laparoscopic duodenal switch (LBPD-DS) in 1999 (7) and demonstrated the advantages of the minimal invasive surgery in decreasing of the surgical complications, especially the pulmonary embolism.

Looking forward to reduce the morbidity and the mortality of the metabolic surgery, the actual strategies recommend the 2-steps LBPD-DS, consisting in laparoscopic sleeve gastrectomy (LSG) for the first step, followed by DS years after. This approach is recommended especially for higher-risk patients (19).

Being aware about the complexity of the procedure and the great responsibility of the follow up program in these patients, we have limited the indication for BPD-DS to the compliant patients who conceive the regular visits and life-time vitamin and mineral supplementation. During the last 10 years, the staging approach, performing LSG for the first step is our current protocol. Laparoscopic BPD-DS is offered to the patients who regained weight and/or have back the T2DM recurrency years after sleeve, gastric plication or gastric bypass. To-date, the number of the BPD-DS patients is still very low, even in the high-volume bariatric surgery centers, but the revisional bariatric surgery after LSG will be more needed in the nearest future. Laparoscopic BPD-DS is a logic and very efficient step after laparoscopic gastric sleeve and its presence into the surgical techniques armamentarium of the Bariatric centers will be mandatory.

This is why, detailed technical and patients' management information for this metabolic surgery procedure are presented.

Conclusions

Current evidence suggests that BPD-DS is the most effective metabolic procedure on obesity-related comorbidities, especially on T2DM. However, due to its technical complexity and concerns regarding severe metabolic

disturbances and malnutrition the utilization of this bariatric surgical procedure is limited compared to other surgical options.

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