14 Biliopancreatic Diversion with Duodenal Switch: Technique and Outcomes

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Chapter Objectives

1. Understand the history of evolution of the duodenal switch operation.
2. Become familiar with the principles of performing the duodenal switch operation.
3. Understand comparative effectiveness of the major bariatric operations.
4. Understand surgical and nutritional complications of the duodenal switch operation.

Introduction

Nicola Scopinaro described the original biliopancreatic diversion (BPD) in 1979 in which a distal gastrectomy was performed with an alimentary limb of 250 cm and a common channel of 50 cm [1]. In the original BPD, the blind end of the jejunoileal bypass (JIB) was eliminated. The blind loop was thought to be responsible for bacterial overgrowth and cirrhosis. The BPD created a more substantial stomach pouch of about 250 mL compared to the Roux-en-Y gastric bypass (RYGB) allowing the patient to eat more normal sized meals, and the weight loss was attributed primarily to fat malabsorption. However, the operation was associated with post-gastrectomy syndromes such as dumping, marginal ulceration, and the potential for diarrhea. The concept of developing the duodenal switch was based on the original studies of DeMeester in dogs that showed when the pylorus was preserved, marginal ulceration was reduced. Hess et al. performed the first BPD/DS in 1988 [2], and Marceau et al. published their results and technique in 1993 [3] in which SG and a post pyloric anastomosis is performed. Ren et al. described the first laparoscopic BPD/DS in 2000 [4], and the same year Sudan et al. performed the first robotic BPD/DS [5].

The BPD/DS is increasingly being recognized as the most effective bariatric operation for excess weight loss (EWL) and is the best operation for resolution of diabetes and hyperlipidemia. In a propensity matched analysis of different bariatric operations, the comparative effectiveness of BPD/DS showed better odds of resolution of diabetes, hypertension, and more weight loss compared to either the RYGB or the sleeve gastrectomy (SG). It was also better than the SG for resolution of reflux disease but less so than the RYGB [6]. However, BPD/DS annual numbers have lagged behind other bariatric operations [7]. It takes longer to perform, is more challenging technically, and has the potential for more technical complications and nutritional deficiencies which may explain some of the reasons behind its slower adoption. However, with better description of minimally invasive techniques to perform BPD/DS and increasing need to revise RYGB and SG for inadequate results, there is growing interest in performing this more aggressive operation.

Preoperative Assessment

The indications for performing a BPD/DS are similar to other bariatric operations with preference given to those patients who have a high BMI, more severe diabetes, or hypercholesterolemia. There is evolving evidence that for patients with a BMI of less than 50 kg/m^2, the rates of malnutrition or excess weight loss are not any different than those for a BMI greater than 50 kg/m^2 [6]. Accordingly, Centers for Medicare and Medicaid allow BPD/DS for patients with BMI > 40 kg/m^2 or >35 with a significant comorbidity and sufficient attempt to lose weight through nonsurgical means. Many other payers use similar criteria.

The contraindications for performing a BPD/DS are the same as for any bariatric operation such as noncompliance, unresolved psychiatric conditions including substance abuse, or overwhelming medical risk. Any patient in whom malab-

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N. T. Nguyen et al. (eds.), *The ASMBS Textbook of Bariatric Surgery*, https://doi.org/10.1007/978-3-030-27021-6_14

sorption should be avoided or those who have anatomical considerations such as dense small bowel adhesions is also not a good candidate for a BPD/DS. Patients are also advised about the side effects of the BPD/DS, and these may be incongruent with their preference or lifestyle.

Patients must undergo multidisciplinary evaluations that include medical nutritional and psychological evaluations. The ability to comply with follow-up and with nutritional supplements is even more important with the BPD/DS. Since the operation takes longer to perform, the ability of the patient to tolerate a longer duration of anesthesia is assessed from a cardiopulmonary standpoint. Vitamin deficiencies must be assessed preoperatively and corrected prior to surgery as it is often harder to do so after the operation. Patient education regarding appropriate compliance with postoperative follow-up and adherence to nutritional guidelines is emphasized. In the era of enhanced recovery, a liver shrinking diet may be prescribed, and for the patients who are very heavy, preoperative weight loss may enable completion of the BPD/DS in a single stage. Bowel prep is avoided to prevent dehydration. Preoperatively, the patients are assessed for duration of DVT prophylaxis that is required postoperatively [8]. They are given a high carbohydrate drink in the morning of the surgery as well as prescribed gabapentin and intravenous acetaminophen. A transverse abdominis plane (TAP) block using lipoidal bupivacaine may also be used to reduce the need for postoperative narcotic pain management. Details of the enhanced recovery protocol are available [9].

Technical Details

A few years ago, the BPD/DS was primarily being performed by laparotomy on account of its complexity. However, over the last few years, surgeons have become more facile in their minimally invasive technique, and several techniques have been described to perform this operation. The essential details of each technique include a sleeve gastrectomy in which the stomach pouch has a larger capacity than that of a stand-alone primary SG operation and is in the range of 150–250 ml. The pylorus is preserved, and the duodenum is divided where the first part of the duodenum becomes adherent to the pancreas. This often corresponds to the location of the gastroduodenal artery (GDA). A post pyloric anastomosis is performed to the alimentary channel. The technique by which this anastomosis is performed has been described variously using the EEA stapler, linear cutter, handsewn, or robotic. The BPD/DS can be performed in a standard Roux configuration or as a loop duodenoileostomy. Proponents of the duodenoileostomy propose a lowered risk of internal hernias and technical complication due to one less anastomosis between the biliary limb and the alimentary limb, while proponents of the standard configuration think that a leak may manifest with clinically worse signs and symptoms because of the presence of bile. Also, biliary reflux in the single loop version may cause additional long-term problems that have been previously described with Billroth-type operations. This debate is beyond the scope of the present chapter, but it is important to note that there are some variations in the limb length and types of anastomosis of the alimentary channel. In the standard BPD/DS, a 250 cm alimentary limb with 100 cm common channel is commonly used, while the common channel is somewhat longer in the loop configuration and is in the range of 300 cm. In contrast to RYGB, the measurements of the bowel in the BPD/DS are from the ileocecal valve, and the limb lengths are marked using either suture or clips to perform the anastomoses at the appropriate distance and in the correct orientation to prevent twisting of the bowel.

Since the average duration of the operation is longer, positioning the patient is important, and they need to be adequately padded and protected to prevent pressure sores. While some surgeons prefer the split-leg position, many others use a standard supine position. Patient positioning, room setup, and trocar placement are optimized depending on the technique for performing the duodenoileostomy. It is important to remember that the operation is performed in three abdominal zones and the room set up accordingly. Access to the abdomen is most often obtained using a Veress needle in the left subcostal area, and an optical trocar is then used to enter the abdominal cavity. Additional ports are placed under direct visualization. The port size needs to consider the size and the brand of the stapler that will be used in the operation. Therefore a liver retractor is placed. The type of liver tractor used is up to the surgeon (Fig. 14.1). Additionally, the liver is often bulky, and occasionally a hiatal hernia repair needs to be performed concomitantly making the liver retractor quite important.

Another debatable part of the operation is performing a simultaneous cholecystectomy. Many surgeons believe that gallstone formation is higher with a BPD/DS than the RYGB due to more wasting of bile salts. In the event that a stone slips into the common bile duct, access may be more challenging after a BPD/DS, as there is no remnant stomach. Also, if the patient develops acute cholecystitis, it may be harder to perform a cholecystectomy in the area of the duodenoileostomy due to scarring from the previous operation. However, other surgeons do not want to spend the additional time and prefer to address a cholecystectomy or common bile duct storms postoperatively, as and when they develop. Depending on whether a cholecystectomy is performed or not, most surgeons will begin the actual BPD/DS operation by performing the sleeve gastrectomy. The greater curvature of stomach is mobilized from the left crus of the diaphragm to the junction of the first part of the duodenum and the pancreas. As mentioned previously, it is important to make the stomach pouch larger in the BPD/DS compared to the stand-

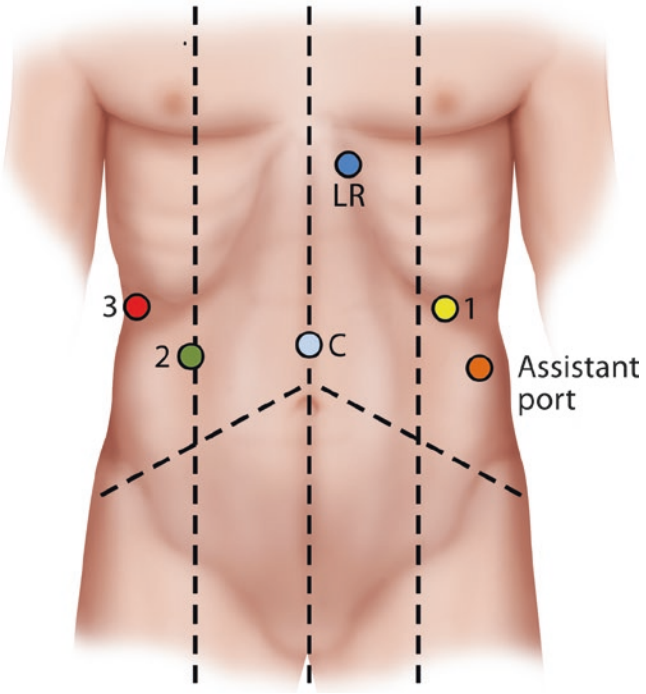

Fig. 14.1 Sample port pacement: C camera port, LR liver retractor, 1 and 3 are accessory ports, and usually stapling is performed through port 2 and assistant port (From: Sudan and Podolsky [24]. Reprinted with permission from Springer Nature)

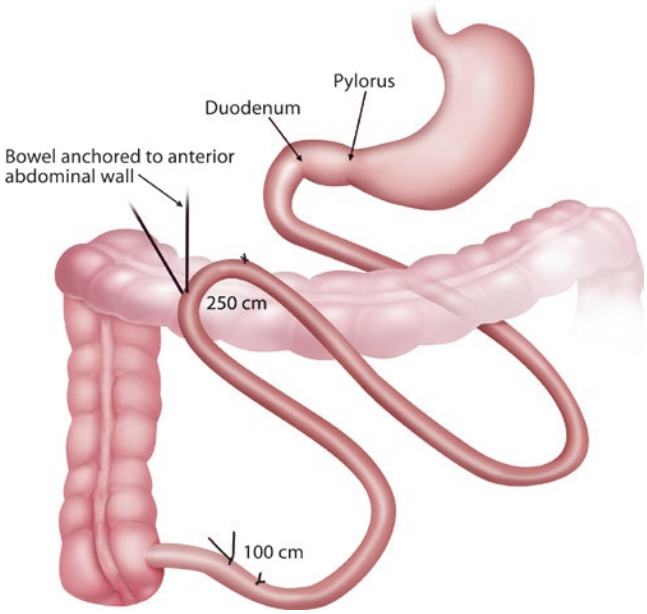

Fig. 14.2 Marking bowel at predetermined distances (100 cm and 250 cm) from the ilececal valve. (From: Sudan and Podolsky [24]. Reprinted with permission from Springer Nature)

alone SG. The mobilization can be performed by any energy device that seals and divides the vessels of the greater curvature reliably. This is often facilitated by entering the lesser sac close to the greater curvature and dividing the leaves of the greater momentum close to the stomach and within the gastroepiploic arcade. The highest short gastric vessel can easily be avulsed, and gentle but adequate retraction to visualize this area is important to prevent bleeding. In addition, it is important to avoid lateral spread of thermal energy to the gastroesophageal junction to avoid leaks in this location. Similar care is used when mobilizing the first part of the duodenum so as to not cause either burns or bleeding. Bleeding obscures visualization and prevents safe transection of the duodenum. A 50–60 French bougie in the stomach is often used as a guide, and the stomach transection is started approximately 5 cm proximal to the pylorus on the antrum. This part of the stomach is thicker than the more proximal stomach. Therefore, a longer leg length stapler is used. Newer staplers are automated and facilitate in selecting the appropriate staple load. More proximally, the stomach becomes thinner, and the leg length can be downsized appropriately to decrease bleeding. Most surgeons reinforce the staple lines on the sleeve to prevent leaks or bleeding. The choice of reinforcement is up to the surgeon, and considerations include cost of the material and the time involved in applying reinforcement. The available choices are buttress material, sutures, or clips. When performing the sleeve gastrectomy, it is important not to narrow the sleeve or spiral the staple line. Appropriate retraction by the assistant and careful application of the stapler prevent these complications. Since the duodenum is thinner, a shorter leg length stapler can be used in this location, and reinforcement is optional. The division of the duodenum is carried out in the area of the GDA, and the surgeon must be careful to not damage this vessel, the portal structures, or the duodenum when performing this maneuver. Familiarity with the anatomy in this area is crucial for safe dissection but not hard to learn with experience.

The next part of the operation involves performing the duodenoileostomy at the premarked bowel lengths (Fig. 14.2). The small bowel at the premarked site (250 cm) is brought up for anastomosis to the proximal stapled end of the duodenum (Fig. 14.3). This is typically performed antecolic although retrocolic techniques have also been previously described. The division of the omentum or creation of a transomental or transmesocolic window is performed depending on surgeon technique and tension being placed on the anastomosis. The anastomosis in the standard BPD/DS is performed 250 cm from the ileocecal valve and is longer in the loop duodenal switch version. It is important to maintain the appropriate orientation of the small bowel so as to prevent a twist that results in an internal hernia, or worse, a closed loop obstruction. The method of performing the duodenoileostomy is variable. In the EEA approach, the anvil of a size 21 stapler is passed orally through the pylorus and seated at the stapled line of the proximal duodenum. The EEA stapler is then passed through

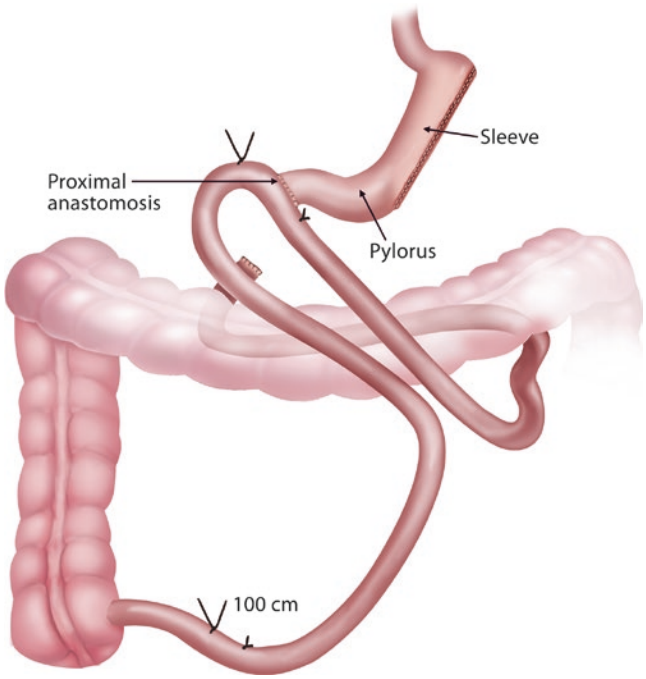

Fig. 14.3 The sleeve gastrectomy is performed, the duodenum is divided, and the bowel at the 250 cm mark is anastomosed to the proximal stapled edge of the duodenum (From: Sudan and Podolsky [24]. Reprinted with permission from Springer Nature)

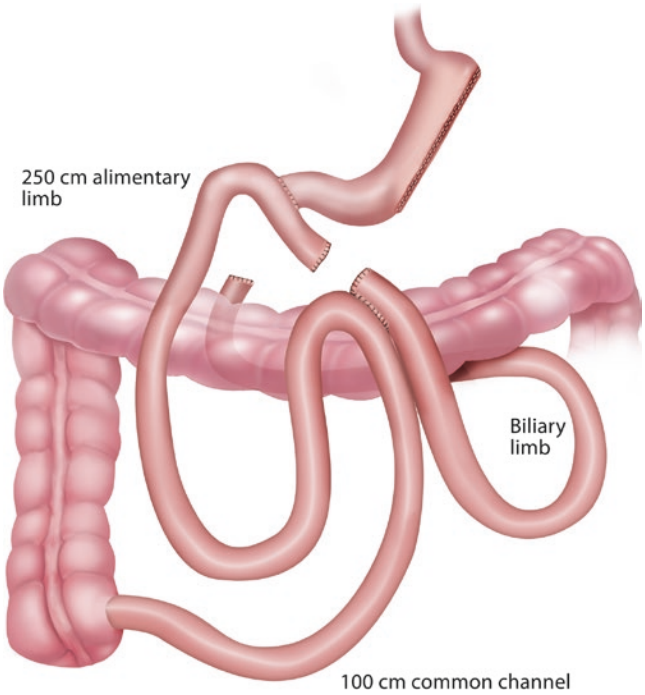

Fig. 14.4 Completion of standard duodenal switch by performing an anastomosis between the alimentary limb at the 100 cm mark to the biliary limb just proximal to the duodenoileal anastomosis and then dividing the biliary limb (From: Sudan and Podolsky [24]. Reprinted with permission from Springer Nature)

the small bowel and engaged with the anvil. After the anastomosis has been completed, the enterotomy for the stapler is closed by suture or stapling. This process is more demanding technically than when performing a circular anastomosis for the RYGB because the anvil has to pass through the pylorus and the distal small bowel is often quite narrow. Therefore, some surgeons have adapted the linear stapler approach to perform this anastomosis. They close the enterotomy using another stapler or hand suturing. This stapling technique is faster and relies less on the suturing skills of the surgeon but may not use the full length of the duodenum. A totally hand-sutured technique can be performed either laparoscopically or robotically. While the laparoscopic technique is faster and less expensive, it demands higher skill levels and may not be as comfortable ergonomically as the robotic technique. If the surgeon is planning a loop duodenal switch, the operation is completed by performing a leak test using either air or methylene blue. In the standard duodenal switch, the distal anastomosis is performed next by approximating the bowel at the 100 cm mark to the biliary limb. The technique for performing the ileoileostomy is more standard. Most often, a 60 mm stapler is used, and the enterotomy for the stapler is closed using suturing or stapling. The surgeon must ensure that the bowel is not narrowed in this process. Finally, the biliary limb is divided near the duodenoileostomy to complete the standard Roux configuration of the BPD/DS (Fig. 14.4). In order to prevent internal hernias, the closure of mesenteric defects between the alimentary limb and the biliary limb using a running nonabsorbable suture has been standard practice. In the antecolic version, and particularly with the loop duodenal switch, the closure of Petersen's defect is debatable. Proponents of closure argue a reduction in internal hernias due to one less anastomosis, and those who leave it open feel that a wide open space is less likely to obstruct. Closure of this space is more difficult in the BPD/DS. Endoscopy with air insufflation to check for patency, leaks, and bleeding is often performed prior to completion of the operation. Methylene blue can also be passed through an orogastric tube to check for leaks. Specimens are retrieved at the end of the case. Larger port sites are closed with a port closure device, and lipoidal bupivacaine can now be injected for TAP block, if not done preoperative, to help with pain control.

Postoperative Management

After a complex bariatric operation, patients undergoing the BPD/DS are monitored in a unit with staff that is adequately trained and equipment that is suitable for managing such patients. With greater implementation of enhanced recovery programs in bariatric surgery, the use of narcotic medication and routine use of patient-controlled analgesia or epidural anesthesia have become the exception. However, patients

should still be monitored closely as many suffer from sleep apnea. There are some nuances in managing the diet of BPD/DS patients that are highlighted here. Patients undergoing a BPD/DS have an intact pylorus and have undergone a sleeve gastrectomy. As a result, it is not unusual for patients to have some degree of gastroparesis or pylorospasm similar to that seen in the stand-alone SG patients. This may predispose them to nausea, and judicious use of anti-nausea medicine, including scopolamine patches, has been very helpful in alleviating this problem. In the RYGB, the stomach pouch is small, and there is no restriction to outflow of fluid from the pouch. Hence, RYGB patients tolerate oral intake sooner than the SG or the BPD/DS patients. The BPD/DS patients also have a larger stomach pouch, and therefore high-volume emesis with subsequent chances of aspiration, needs to be kept in mind when initiating oral intake. Once the patients are nausea-free and are on a normal clinical track, liquids are initiated in small quantities and advanced to protein shakes. The duration of the liquid diet varies with bariatric program but is commonly about 2 weeks, at which time patients are started on a soft diet and gradually progressed to more normal consistency diet, over the next 3 months. Vitamins are supplemented as per ASMBS recommendations for malabsorptive operations [10]. If a leak test has been performed during the operation, routine postoperative upper gastrointestinal series is not performed, unless clinically indicated. Early ambulation with assistance is encouraged, and routine use of drains, nasogastric tubes, and Foley catheter is not usually practiced. For DVT prophylaxis, sequential compression devices are used routinely, and appropriate anticoagulation medication is administered, as assessed by the patient's need preoperatively. Patients are ready for discharge when they are tolerating adequate amount of liquid to prevent dehydration, pain is under good control, and they are ambulating well. The average length of stay for a BPD/DS patient is longer than that of stand-alone SG or RYGB. When patients have return of bowel function, they may experience urgency and frequency. This normalizes to an average of 2–3 soft bowel movements a day. Patients need to be counseled regarding this expectation. If bowel movements are excessive and an infectious colitis has been ruled out, antidiarrheal agents such as loperamide or diphenoxylate-atropine can be used.

Complications

Surgical

Comparative effectiveness among different bariatric operations shows higher complication profile at 30 days and 1 year for the BPD/DS and is discussed below in greater detail in the section on outcomes [6]. Leaks and bleeding are managed similar to other bariatric operations, and the need to manage these complications operatively depends on hemodynamic stability as well as radiographic findings. Evidence of a free leak necessitates an urgent operation. Stenting a sleeve leak or a DI anastomosis leak, draining any fluid collections percutaneously, making the patient nil per os, and feeding them through parenteral access, can avoid an operation in suitable patients. Bleeding can be managed with fluid and blood replacement or endoscopic management using epinephrine injections or clips. More aggressive bleeding or one that cannot be accessed endoscopically needs operative intervention. The chances of PE are also higher after a longer operation. Bowel obstructions in BPD/DS can be particularly dangerous because these patients do not have a remnant stomach. Obstruction in the biliary limb or common channel may therefore manifest itself with the blowout of the duodenum, if not treated in a timely fashion. Abdominal pain should be investigated with a CAT scan, and patients with dilation of the biliary limb should be promptly explored to prevent this from occurring. Typically, the bowel is traced back from the ileocecal valve to ensure appropriate orientation. Nausea and vomiting may also be attributable to strictures of the sleeve, and a technique to widen the stricture by performing a strictureplasty has been described [11]. Another option is to perform a RYGB proximal to the stricture, but this operation is more complex in the face of a previous BPD/DS. Conversion to a RYGB may also be considered if patients have intolerable reflux. Sometimes in the absence of any anatomic abnormality, nausea is of a metabolic nature and improves with time. Resolution of nausea may take months and requires careful monitoring and supplementation of nutrition in the meantime. Despite the statistically higher complication rate, the rate of complications from BPD/DS is still acceptable from a clinical standpoint.

Nutritional Complications

Duodenal switch patients do not suffer from dumping symptoms, and as a result, they can eat larger portions and tolerate a wider variety of foods. If they are not careful and consume sugars and starches, weight loss may be inadequate. Also, as the bowels are bypassed quite distally, many patients will become lactose intolerant, and most malabsorb fat including the fat-soluble vitamins such as A, D, E, and K. If patients are not mindful of the type of food they eat, they may also have excessive flatulence and steatorrhea. The fat-soluble vitamins need to be supplemented in their water-soluble analogue form and often need to be specially ordered and cost more. Noncompliance with these vitamins may result in deficiency states. Duodenal switch patients are often more predisposed to vitamin D deficiency and a concomitant increase in parathormone level. Deficiencies related to minerals such

as iron, copper, zinc, and magnesium can also be seen. In order to detect and adequately treat these vitamin deficiencies, serum levels need to be assessed at least annually, and more frequently if needed. Recommended doses of vitamins and micronutrients are available through ASMBS guidelines [10]. As stated previously, it is important to obtain these levels preoperatively and correct them prior to surgery. Patients who have chronic nausea and vomiting are also predisposed to vitamin B deficiency [12–19].

Another major concern with the BPD/DS is protein deficiencies. Marceau et al. increased the length of the common channel from 50 to 100 cm and described a decrease in the incidence of protein deficiency compared to the Scopinaro BPD. He also demonstrated reduced bowel movements and improved levels of fat-soluble vitamins [20]. It is conceivable that increasing the length of the common channel in the loop version of the duodenal switch may further decrease nutritional deficiencies. BPD/DS shows remarkable stability in maintaining weight loss over a long period of time, but a few patients need to have the operation reversed due to excessive malnutrition or bowel side effects. In experienced centers, about 2% of the patients may need a reversal for these reasons. This can be accomplished by either creating a more proximal side-to-side anastomosis between the biliary and the alimentary limb, or the Roux limb can be disconnected at its junction with the common channel and moved more proximally. Another issue with more distal bypass is the formation of oxalate kidney stones. Normally the oxalates in the gut bind to calcium and are excreted in stool. In BPD/DS due to inadequate binding in the gut, oxalates are absorbed and excreted through the kidneys where stones can form. This can be avoided by consuming supplemental calcium that binds to oxalates and prevents its absorption. Adequate hydration and making the urine more acidic help dissolve oxalate crystals in the urinary tract.

Outcomes

The vast majority of studies in the literature are single-center retrospective studies from investigators who have extensive experience with BPD/DS [2, 3, 21]. There is one randomized study that compares BPD/DS to RYGB and patients with a BMI greater than 50 kg/m^2 [19]. Sudan et al conducted a multi-institutional propensity matched analysis on comparative effectiveness of bariatric operations that included 130,796 subjects, 1,436 patients underwent BPD/DS and were compared with 5,942 SG and 66,324 RYGB patients. The remaining underwent LAGB. This study demonstrated that BPD/DS had the greatest BMI change at 1 year, followed by RYGB, SG, and AGB, respectively. When using LAGB as a reference, patients undergoing BPD/DS had a BMI reduction of 10.6 units versus 9.3 for RYGB and 5.7 for SG. BPD/DS had the greatest odds for remission for diabetes type II (OR = 5.62, 95% CI: 4.60–6.88), RYGB (OR = 3.5, 95% CI: 3.39–3.64), and SG (OR = 2.11, 95% CI: 1.92–2.31). Remission of hypertension was also the best after BPD/DS. However, for GERD the best operation was RYGB followed by BPD/DS, and it is noteworthy that the BPD/DS was still better at resolving reflux than SG. In this study, adverse events (AE) and serious adverse events (SAE) at 30 days and 1 year for the unmatched cohort were higher for the BPD/DS compared to the other operations. At 30 days, unmatched AEs were 8.04% for SG, 11.77% for RYGB, and 20.26% for BPD/DS. At 1 year, the AE rates were 6.5% for AGB, 10.03% for SG, 17.99% for RYGB, and 27.52% for BPD/DS. SAE rates for AGB at 30 days were 0.23% and increased to 0.81% for SG, 1.35% for RYGB, and 3.63% for BPD/DS. At 1 year, SAE rates increased slightly to 0.3% for AGB, 0.93% for SG, 1.58% for RYGB, and 4.60% for BPD/DS [6].

Rates of bleeding at 30 days were 0.63% for SG, 1.38% for RYGB, and 0.99% for BPD/DS. Leaks were 0.14% for SG, 0.36% for RYGB, and 0.89% for BPD/DS. PE was 0.11% for SG, 0.13% for RYGB, and 0.54% for BPD/DS. At 1 year, these rates increased only slightly suggesting that beyond 30 days operative complications remained relatively stable. After matching, the odds of adverse events and severe adverse events remained higher for the BPD/DS at 30 days and 1 year [6].

Longer-term single-center retrospective studies have similarly demonstrated excellent weight loss and resolution of comorbidities. A study comparing BPD/DS with RYGB in patients with a BMI of ≥50 kg/m^2 demonstrated faster and better resolution of comorbidities and higher weight loss for BPD/DS with no significant increase in morbidity or mortality [21]. In another study, 810 BPD/DS patients with a BMI < 50 kg/m^2 demonstrated excellent weight loss and resolution of comorbid conditions suggesting its appropriateness for lower BMI patients [22]. Patient satisfaction was also excellent with acceptable complications rates. Quality of life studies after BPD/DS are limited with regard to gastrointestinal symptoms. The average BPD/DS patient has been shown to have an average of 2.7 bowel movements a day [23].

Conclusion

BPD/DS has better weight loss and resolution of certain comorbid conditions such as diabetes, hypercholesterolemia, and hypertension. The operation is now being performed using a variety of minimally invasive techniques, and although still not very common, its popularity seems to be increasing. It is associated with nutritional and higher technical complication rates that can be managed by an experienced team.

Question Section

1. Regarding the biliopancreatic diversion without the duodenal switch, all of the following are true except:
   A. There is no blind end.
   B. A distal gastrectomy is performed.
   C. The operation has shown excellent weight loss.
   D. Rate of marginal ulcerations is low.
2. According to a large database analysis comparing Duodenal switch to Roux-en-Y gastric bypass and sleeve gastrectomy operations the following is true:
   A. Diabetes resolution is the best with a duodenal switch.
   B. GERD resolution is best with a duodenal switch.
   C. The operative complications are clinically unacceptably high with a duodenal switch.
   D. The operative complications are statistically equivalent between a duodenal switch and a gastric bypass.
3. The following is true regarding the duodenal switch:
   A. Dumping is common.
   B. Steatorrhea is common.
   C. Vomiting is common.
   D. Marginal ulcer is common.
4. Regarding vitamin deficiencies following a duodenal switch, the following is true:
   A. Vit D deficiency is uncommon.
   B. Use of water-soluble analogues of fat-soluble vitamin is mandatory.
   C. Use of fat-soluble analogues of water-soluble vitamins is mandatory.
   D. Patients do not need supplementation of vitamin K.

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