LRYGB: The Linear Technique

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Irfan Halim, Dimitri J. Pournaras, Sanjay Agrawal, and Yashwant Koak

Abstract

The evolution of the linear technique of laparoscopic Roux-en-Y gastric bypass for obesity is described. The two different approaches of the linear technique—reverse technique and the omega-loop, including the operative steps, are described here. The theatre set-up, intra-operative considerations and the postoperative treatment are included.

Keywords

Bariatric Surgery • Gastric Bypass • Laparoscopy

19.1 Introduction

The Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) procedure or "gastric bypass" is now one of the most popular procedures in bariatric surgery worldwide. There is considerable variation in the way this procedure is performed. In the first reported LRYGB a circular stapler technique was used [1]. Subsequently a linear stapler technique was described [2]. The first reported laparoscopic gastric bypass in Europe was performed with a variation of the linear staple technique which utilises an omega loop [3]. A hand-sewn technique for the gastrojejunostomy was also described [4]. There is considerable debate on the optimal technique for gastrojejunostomy anastomosis.

The debate regarding the most appropriate technique for creation of the gastrojejunal anastomosis is not new [5, 6] and there is considerable variation in the technique between individual surgeons [7]. It was reported in the United Kingdom in 2010 that of the 3817 gastric bypass operations performed. In 22.4 % of operations the circular stapling technique, 36.2 % the linear stapling technique, and in 33.4 % a hand-sewn technique was used. The method was not specified in 8 % [8]. It is widely accepted that the individual choice of approach is due to surgeon's preference and usually determined by previous training. Familiarisation with all the techniques is advised especially with the ever-increasing number of patients who have undergone gastric bypass surgery and present in the emergency setting. Knowledge and familiarity of other techniques will equip the surgeon with confidence in dealing with emergency or unexpected intra-operative situations such as stapler misfire, failed leak test or unusual operative anatomy which may not favour the technique being deployed by the surgeon.

This chapter discusses the linear technique and its variations in performing LRYGB and gives an overview of the procedure with detailed description of the key components of the operation. It is based on the authors' preference for the execution of particular techniques, however possible variations are also mentioned. Regardless of surgical preference, the overall procedural success is dependent on methodically

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following the main principles and key steps rather than debating over the superiority of one technique variation over another.

19.2 Pre-Procedural Setup

In performing the LRYGB, appropriate surgical preparation with setup and positioning of the patient is essential before commencing the surgery. Preoperative planning is described in more detail in another chapter in the book, however it is briefly mentioned again as this step is critical to the success of the operation as a whole. This consists mainly of:

- Liver shrinkage diet
- Informed consent
- Thromboprophylaxis
- Prophylactic antibiotics
- On-table setup and positioning

The liver shrinkage diet commences 2–4 weeks prior to surgery. This consists of a low calorie or low carbohydrate diet with the objective to reduce the liver size, improve intraoperative exposure and minimise abdominal wall splinting.

Thromboprophylaxis measures include the routine use of stockings for 30 days postoperatively, low molecular weight heparin preoperatively and then for 7–14 days postoperatively. Lower limb pneumatic compression devices are also used intraoperatively and during the immediate postoperative period.

Prophylactic broad-spectrum intravenous antibiotics are routinely given at induction and also continued for a further two postoperative doses.

Informed consent is obtained by the operating surgeon with risks, benefits, and alternative options to treatment explained to the patient. Details regarding the procedure and the postoperative course are discussed. At the same time patients are also consented for alternative procedures such as sleeve gastrectomy, if the bypass cannot be carried out. Patients are also informed that rarely neither procedure is feasible following diagnostic laparoscopy leading to abandoning of the operation.

During the consent process, complications mentioned include those specific to the bypass procedure such as bleeding, infection, port-site hernia, visceral injury, need for conversion to open procedure, anastomotic or staple line leakage, internal herniation, dumping syndrome, gastric or stomal ulceration, anastomotic stricture, malnutrition with the need to be on vitamin and elemental supplements lifelong with regular blood tests. General risks of surgery and anaesthesia such as deep vein or pulmonary thrombosis, atelectasis, pneumonia, myocardial infarctions, stroke, anaesthetic complications and mortality risk (less than 1 in 300) are also mentioned.

The patient then walks to the operating table and lies down on the operating table comfortably prior to anaesthesia.

After anaesthetic induction, the patient is placed in a reverse Trendelenburg position with the split-leg approach. The operating surgeon stands on the right side of the patient with the assistant between the legs, or vice versa and the scrub nurse on the left side of the patient. Dr Koak prefers standing centrally between the legs position with the assistant on either side. The laparoscopic equipment including the monitor is positioned just above the patient's head in the midline or just to the right of it. An orogastric tube (30 Fr) is inserted by the anaesthetist to decompress the stomach. Note that the withdrawal of this tube into the oesophagus is essential prior to any stapling in the stomach.

19.3 Procedural Set-Up

The procedure commences with skin preparation and draping of the patient. A pneumoperitoneum is created with the insertion of a Veress needle in the left mid-clavicular line just below the costal margin and insufflation to an intra-abdominal pressure of 15 mmHg is commenced.

Tip: Pressures between 12 mmHg to 20 mmHg may be used depending on the surgeon's preference and patient factors. A pressure higher than 15 mmHg is not generally recommended unless for short periods of time to overcome a difficult step in the operation after which the original pressure is resumed.

Four 10/12 mm trocars and a liver retractor are inserted (Fig. 19.1).

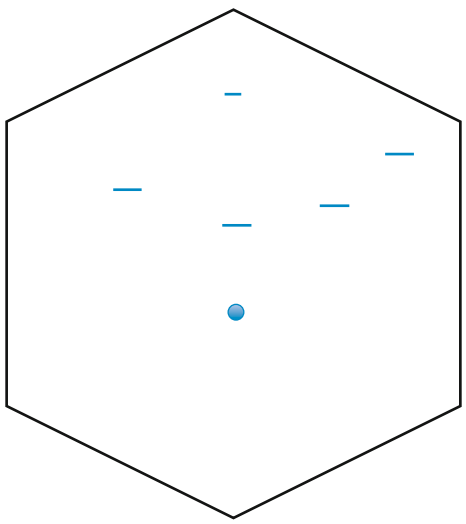

Fig. 19.1 Abdominal trocar/ports setup (see above)

The first trocar is inserted in the midline, 15 cm below the xiphisternum. We utilise an optical non-bladed trocar for the first entry to minimise haemorrhage and port-site hernia occurrence. Some surgeons prefer a position left of midline at the highest point of dome during insufflation for the first trocar, in line with hiatus, to decrease port site hernia issues.

The second trocar is inserted in the left flank usually one hand's breadth to the left and slightly cranial to the first port.

The third trocar in the right upper quadrant usually at the midpoint between the first port and right costal margin.

The last trocar is inserted in the left upper quadrant inferiolaterally to the Veress needle insertion site or just under the costal margin. The four trocars are like a smiling face position and provide the necessary triangulation required.

A 5 mm incision in the sub-xiphisternal midline is used for the insertion of the liver retractor.

Tip: There is considerable variation in exact port placement between surgeons and with different patients. Thus an individual surgeon may not necessarily use the same port sites depending on the patient's particular anatomy. Our recommendation is to place the first trocar as per the surgeon's individual preference and then assess the abdomen under direct vision for the optimal placement of the remaining ports.

An initial diagnostic laparoscopy is performed with inspection of the hiatus and with the objective to ensure that no abdominal adhesions are present so that the procedure is feasible. Any hiatus hernia seen is repaired as a cruroplasty prior to formally commencing the bariatric part of the operation. A very large hiatus hernia may require insertion of a mesh and the operation can be performed as a 2-step procedure to reduce the risks associated with long operative time. Simple visceral or abdominal wall adhesions may be divided to allow the LRYGB to progress. In difficult cases it is advisable to check if the bowel is free enough to allow mobilisation to the stomach. At this stage, a decision can also be made to proceed with a sleeve gastrectomy or other procedure if a bypass is deemed to be challenging or risky based on laparoscopic findings or not to proceed at all.

19.4 Laparoscopic Roux-en-Y Gastric Bypass

Once appropriate setup and diagnostic laparoscopy have been completed and a decision to proceed with gastric bypass is made, the surgeon must proceed with the main steps in performing the operation.

The four main steps in performing any LRYGB are:

- Formation of the gastric pouch
- Creation of a gastrojejunal anastomosis (GJA)
- Creation of the jejunojejunal anastomosis (JJA)
- Other essential steps such as closure of hiatus hernia, closure of hernia defects and leak test.

Note that the main steps are not performed in any particular set order and is subject to variation and individual surgeon's preference. We describe the two main variations of the linear stapled technique below in this chapter. The first variation—REVERSE LRYGB—creates a JJA first and then a gastric pouch followed by a GJA (Video 19.1). The second variation which uses the omega loop approach commences with the creation of the gastric pouch and the GJA followed by the JJA. The omega loop technique utilises the gravity traction afforded by the gastrojejunostomy and favoured by many surgeons. The mesenteric or Peterson's hernial defects may be closed as they are created or at the end of the procedure. Any hiatus hernia closure if required is usually done as the first step and the leak test is the final step. One of the key steps is dividing the omentum to prevent undue traction on the anastomosis. This step is essential to prevent omental traction. The omentum is divided longitudinally up to the transverse colon. Care must be exercised to prevent omental ischaemia or necrosis. This step can be avoided if the omentum is very thin.

There are three main areas in which variations to the LRYGB are noted.

- Anastomosis technique
  - Linear stapled
  - Circular stapled
  - Hand-sewn
- Alimentary limb configuration
  - Antecolic or retrocolic
  - Antegastric or retrogastric
- Length of both biliopancreatic (BP) and alimentary limbs
  - BP limb 25 cm/50 cm/100 cm (longer lengths are favoured for type 2 diabetes melitus, T2DM)
  - Alimentary limb 100 cm/150 cm/200 cm (longer lengths are favoured for T2DM)

The authors' preference is to use an antecolic, antegastric configuration with the linear stapled technique [9, 10] while Dr Agrawal prefers a retrocolic antegastric technique with limb lengths being adjusted to the patient's particular co-morbidity. In this chapter, we describe two variations upon this technique. The circular stapler technique and the hand-sewn technique will be described in detail in following chapters.

19.5 First Variation by Sanjay Agrawal

The main steps of this procedure in order are:

- Jejunojejunal anastomosis with closure of the JJA mesenteric window
- Creation of gastric pouch
- Gastrojejunal anastomosis with leak test

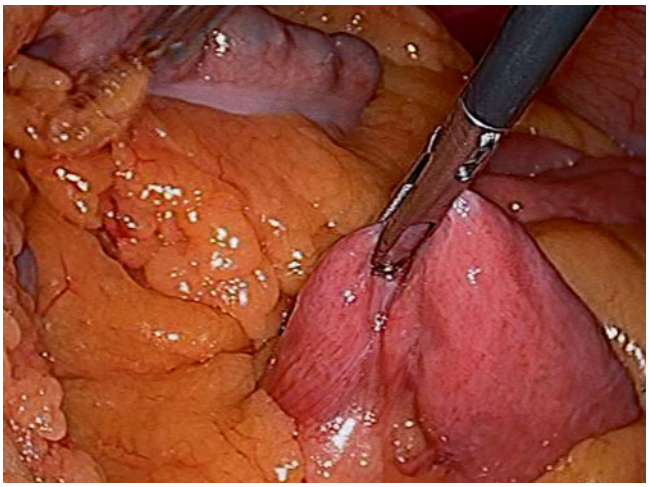

Fig. 19.2 Duodeno-jejunal flexure

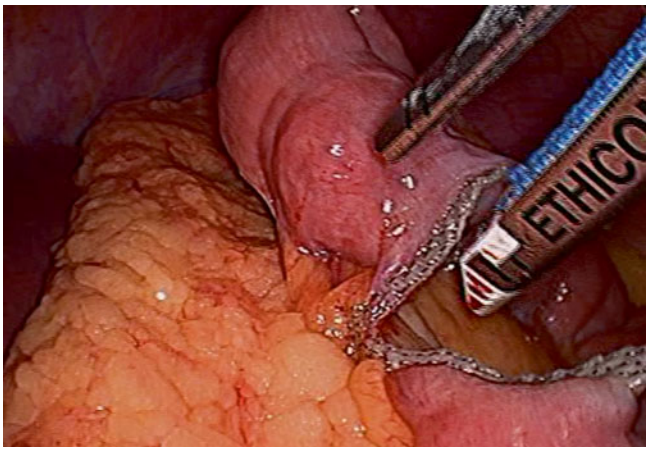

Fig. 19.3 Stapled division of small bowel

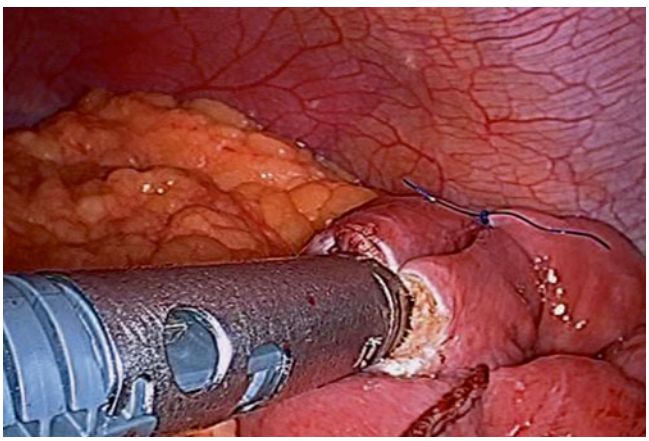

Fig. 19.4 Stapled jejuno-jejunostomy with approximation suture visible

19.6 Jejuno-Jejunal Anastomosis with Closure of the JJA Mesenteric Window

After performing a diagnostic laparoscopy we commence the LRYGB procedure with displacement of the omentum cephalad and identification of the duodeno-jejunal (DJ) flexure (Fig. 19.2) at the ligament of Treitz. The BP limb is measured to 25 cm from the DJ flexure and divided with a 45 mm 2.5 mm (Ethicon™ white cartridge) linear stapler (Fig. 19.3) and the mesentery is divided with an energy device (Harmonic ACE ®—Ethicon ™). From the distal stapled end the alimentary or Roux limb is measured accordingly. Dr Agrawal routinely uses a 100 cm alimentary limb for patients with a BMI of 40 kg/m^2 or less and 150 cm for patients with BMI of more than 40 kg/m^2.

The two limbs (BP limb and measured alimentary limb) are approximated with a 2/0 monofilament suture at the antimesenteric borders. Two enterotomies are performed using the energy device. The jejuno-jejunostomy is formed with one firing of a 45 mm 2.5 mm linear stapler in a side-to-side fashion (Fig. 19.4) and the enterotomy is closed with a continuous 2/0 absorbable monofilament suture.

Tip: Dr Agrawal's preferential technique is to use 2 × Monocryl ® (Ethicon ™—poliglecaprone 25) continuous sero-muscular sutures from either end of the enterotomy and meet in the middle with the tying of both sutures to each other. A second interrupted layer of a few sutures can also be used to reinforce and reduce tension on the suture line.

The internal hernial defect created by the JJA is closed using a continuous purse-string non-absorbable braided suture (Ethibond Excel ®- EthiconTM) or Autosuture device® (CovidienTM)(Fig. 19.5) depending on the surgeon's preference. The omentum is then split in a cranio-caudal direction with the use of the harmonic scalpel to minimise any tension on the Roux limb and GJA.

19.7 Gastric Pouch Formation

The liver retractor is placed prior to pouch formation in order to assist visualisation of the anterior gastric wall and lesser curve. The creation of the pouch commences with the creation of a window on the lesser curve just on the perigastric border at the level situated between the 2nd and 3rd gastric vessels (Fig. 19.6). Dissection occurs using a combination of energy device and blunt manipulation and continues along the posteromedial wall of the stomach until the lesser sac is reached. Care should be taken to avoid entering the stomach by mistakenly dissecting its fibres.

A lesser curve based gastric pouch is created with firings of a 45 mm 3.5 mm (Ethicon™ blue cartridge) linear stapler to create a reverse-L shape (Fig. 19.7). The orogastric tube is removed from the stomach prior to any stapling and the first firing of the stapler is horizontal from the lesser curve. At this

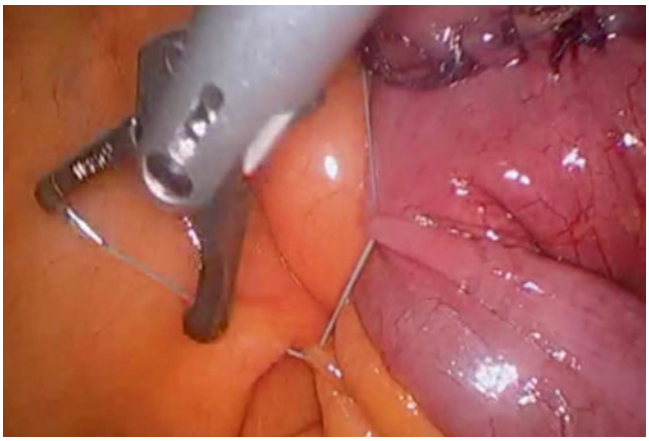

Fig. 19.5 Closure of jej-jej mesenteric window to prevent internal hernia

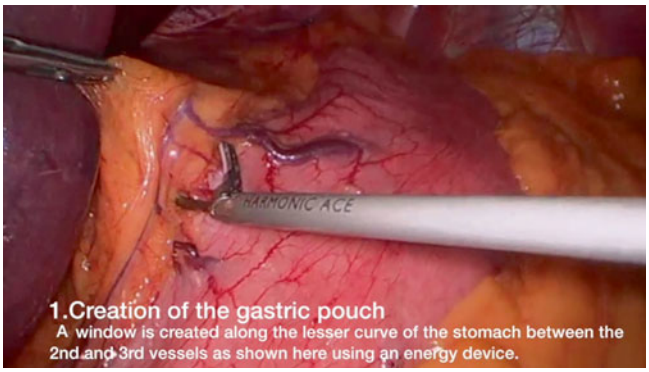

Fig. 19.6 Gastric pouch creation

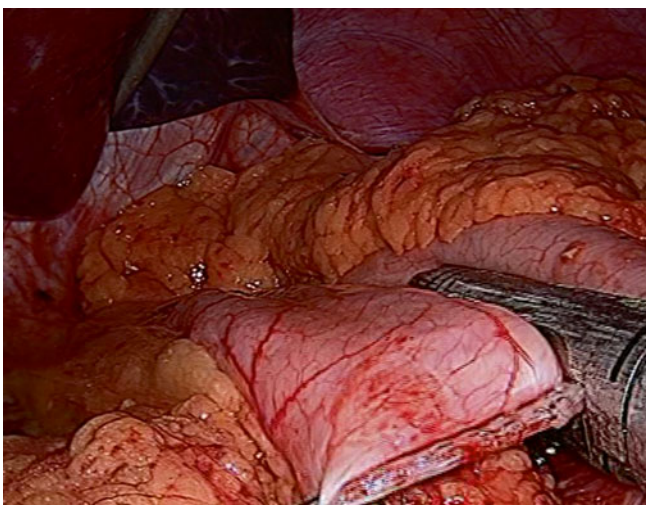

Fig. 19.7 Stapling to create gastric pouch in reverse-L shape

point, the orogastric tube is re-inserted and aimed towards the newly created first staple line. The subsequent staples are fired in a cephalad direction alongside the orogastric tube for calibration and directed towards the angle of His. The aim is to create a pouch for a volume of no more than 20 ml. A combination of sharp and blunt dissection may be required at the angle of His in order to separate the stomach from the diaphragmatic adhesions and allow the final stapler cartridge to fully divide the gastric pouch and remnant stomach into separate entities.

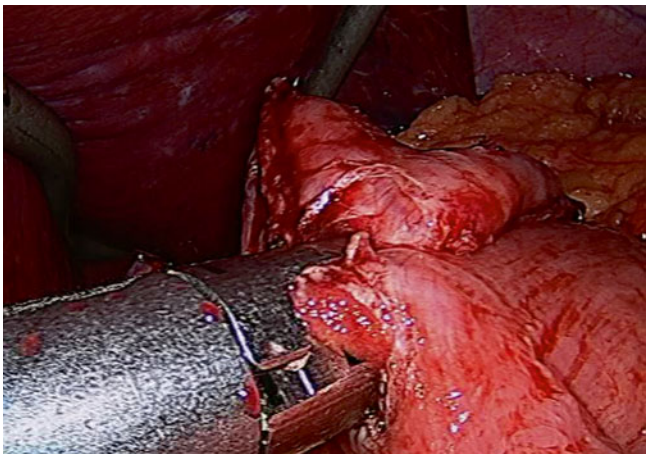

Fig. 19.8 Stapled Gastrojejunostomy

19.8 Gastrojejunal Anastomosis and Leak Test

A gastrotomy is created which allows the linear stapler to be inserted for the GJA. We prefer to make the gastrotomy at the right-angle junction between the horizontal and first vertical staple lines. It is presumed that removal of this least vascular area will minimise the subsequent risk of leakage from ischaemic breakdown and prevent the formation of future marginal ulcers.

The alimentary limb staple line is brought to the pouch in an antecolic fashion. A jejunotomy is performed using the energy device and the gastojejunal anastomosis is formed with the single firing of the 45 mm 3.5 mm (Ethicon™ blue cartridge) linear stapler (Fig. 19.8). The enterotomy is then closed in two continuous sero-muscular layers over a 30 Fr oro-gastric tube with 3/0 monofilament absorbable sutures similar to the JJA. A leak test with 50–100 ml of methylene blue dye via the orogastric tube is routinely performed. If this is satisfactory, the procedure is completed with checking for haemostasis, suctioning any residual fluid and the insertion of a Robinson's 20 Fr drain in the left upper quadrant. All ports are removed under vision and skin incisions closed with 3/0 monofilament absorbable sutures.

Postoperatively all patients are encouraged to mobilise as much as possible as well as to perform extensive bed-side exercises taught to them preoperatively. Special medications given usually just for the postoperative period include intra-

venous antibiotics, fluids, omeprazole, analgesia, ondansetron, saline nebulisers, sips of water by straw only for immediate postoperative period. On the first postoperative day further free fluids are encouraged to be sipped by straw only and 20 ml of peppermint water every 6 h to reduce abdominal discomfort. Daily enoxaparin and thromboembolic device (TED) stockings are commenced from the date of surgery. The Robinson's drain is removed usually within 36 h and the patient discharged home usually within 48 h if all vital signs and blood results are within expected parameters.

19.9 Second Variation by Yashwant Koak

The omega loop, a very popular technique described below is favoured by Dr Koak [3].

The procedure commences with the establishment of a pneumoperitoneum as before and trocar insertion. The first trocar is inserted 2.5 cm to the left of the midline in-line with the oesophagogastric hiatus one handsbreadth or 15 cm below the xiphisternum. The remaining ports are placed as previously described. A diagnostic laparoscopy is performed initially with the closure of any hiatus hernia found.

The main steps of this procedure in order are:

- Creation of the gastric pouch and splitting of the omentum
- Gastrojejunal anastomosis
- Jejunojejunal anastomosis
- Closure of hernia defects and leak test

This technique commences with the formation of the gastric pouch as described earlier in this chapter and the liver retractor is required to be setup from the time of trocar insertion. In difficult cases Dr Koak first checks if the bowel is mobile and able to reach the stomach pouch before commencing the formation of the gastric pouch. After fashioning a small gastric pouch a gastrotomy is also performed at this stage as preparation for the GJA (EndoGIA™—Covidien™ staplers tan 45 mm for horizontal and 60 mm for linear part). Dr Koak utilises an antecolic antegastric approach.

The greater omentum is divided in a cranial direction with the energy device aiming to shorten the distance between the jejunum and the gastric pouch and reduce any tension on the anastomosis. Note that this step can be excluded if the omentum is very thin. Care must be taken to prevent omental ischemia or necrosis.

Similar to the first technique, the alimentary limb is measured to a distance of 50 or 100 cm depending on the surgeon's preference. Dr Koak prefers to use a 50 cm BP and 150 cm Roux limb for most patients except those with T2DM in which a 100 cm biliary limb and 200 cm Roux limb are used.

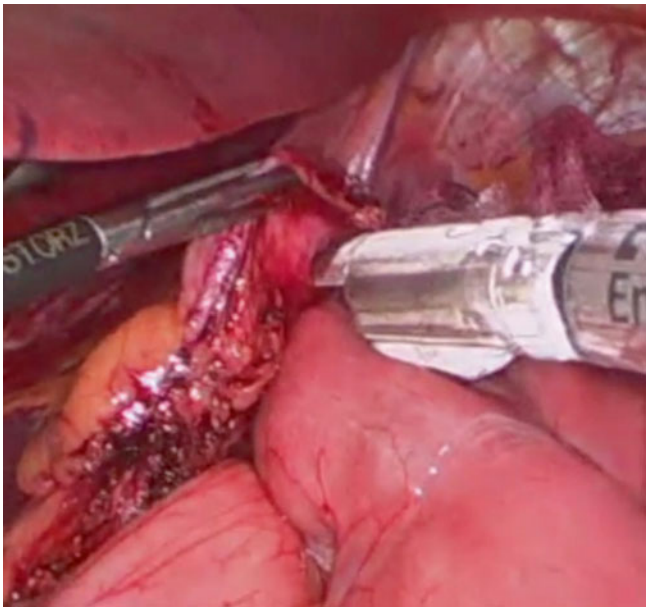

Fig. 19.9 Stapled loop gastrojejunostomy for Omega-loop technique

The measured BP limb is brought up to the gastric pouch gastrotomy and a further enterotomy is created at the measured length. A tan linear 45 mm stapler (EndoGIA™—Covidien™) is used to create the GJA (Fig. 19.9) and the resulting enterotomy is closed in a single layer of continuous absorbable 2/0 braided absorbable (Vicryl®—Polyglactin 910 Ethicon™) suture. Care must be taken to tighten each suture insertion to prevent leak as braided suture can't be pulled at the end.

The remaining distal limb length used to create the alimentary or Roux limb is measured from the GJA distally and an enterotomy made on the anti-mesenteric border at the appropriate measured distance. An enterotomy is then made on the BP limb a few centimetres proximal to the GJA loop anastomosis and a tan (EndoGIA™—Covidien™) stapled 45 mm anastomosis is made in a side-to-side fashion through both enterotomies (Fig. 19.10). The resulting defect is stapled across using the same stapler and the BP limb is divided using the stapler just proximal to the loop GJA to leave a very short hockey stick (Fig. 19.11). Another variation is using a totally stapled jejuno-jejunal anastomosis in an H-shaped configuration which Dr Koak favours, utilising 2×45 and 1×60 mm staplers.

The mesenteric defects (Petersen's and JJA mesentery) are closed using 0 non-absorbable braided (Ethibond Excel ®- EthiconTM) sutures in a purse-string manner with an anti-kinking suture. A methylene blue leak test is performed using 50 ml of diluted dye under pressure to check for leakage. Any pooled fluids from surgery are suctioned to dryness and drains are not routinely placed unless there is intraoperative concern or patient factors dictate a high risk of bleeding. The liver retractor and all ports are removed under

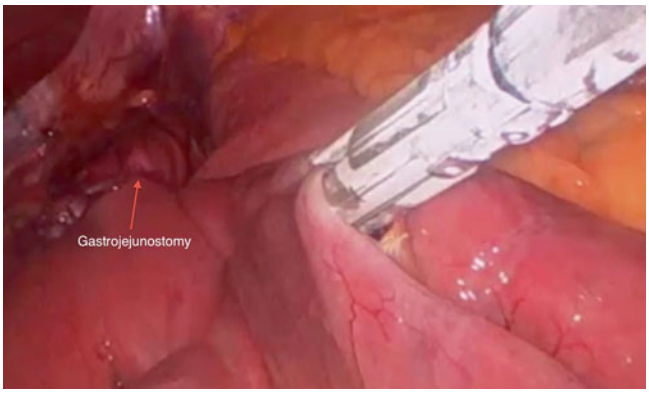

Fig. 19.10 Stapled jejunojejunal anastomosis to create Omegaloop

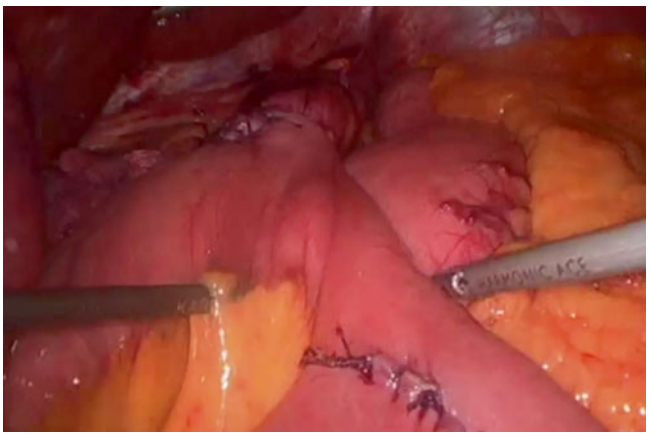

Fig. 19.11 Completed Omega-loop with gastrojejunal anastomosis and jejunojejunal anastomosis visible before separation of alimentary and pancreaticobiliary channels by stapled division of small bowel between the two anastomoses

vision. The skin closed with absorbable monofilament 3/0 sutures or skin clips and local anaesthetic (30 ml 0.5 % Chirocaine) infiltrated into the wounds and fascia.

The postoperative care remains similar to that described in the first variation.

Following the enhanced recovery principles, no nasogastric tube is left in place postoperatively. Drains and urinary catheters are not routinely used. Free clear fluids (30 ml/h) by straw are allowed on the day of surgery using an enhanced recovery protocol. The patient is prescribed breathing and leg exercises/h and early mobilisation is commenced. Liquid diet is introduced on the first postoperative day and for the rest of the first postoperative week. For the next 2 weeks thicker liquid is commenced. Subsequently a soft diet is suggested with the objective of an intake of 1,000–1,200 kcal per day by the fifth postoperative week for 2 weeks. Solid food diet can then commence. Patients are warned that this may vary between individuals.

Mobilisation starts on return to the ward. A proton-pump inhibitor is prescribed for 3 months with the objective to reduce the risk of anastomotic ulcers. The patient is discharged home on the first postoperative day unless there are concerns related to patient recovery, blood test results or home circumstances. Early relaparoscopy is favoured if surgical concerns warrant further assessment.

Key Learning Points

- The linear stapled technique may be used to perform a Laparoscopic Roux-en-Y Gastric Bypass operation for the treatment of morbid obesity
- Essential preoperative preparations are necessary for a successful outcome with the bypass procedure
- Variations in technical setup and operative procedure can be used depending on surgeon preference. We introduce the "reverse technique" and the "omega-loop technique".
- The importance in good procedure execution lies in following the principles and key steps in a logical order.
- Postoperative protocols should be utilised to ensure a good outcome and safe discharge with minimal complications.

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