To have or not to have the ring: early and late surgical complications after banded Roux-en-Y gastric bypass

Czy implantacja silikonowego pierścienia stanie się standardem w chirurgii otyłości: wczesne i późne powikłania po bypassie żołądkowym według Fobiego

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Summary

The prevalence of obesity in the United States is increasing to epidemic proportions. At present, more than 60% of Americans and more than half of Germans are overweight. While a variety of medications are available for the treatment of obesity, none results in the long-term loss of more than 10% of body weight. Surgical treatment of severe obesity is the current standard. Several surgical procedures are nowadays available, including gastric bypass, sleeve gastrectomy, biliopancreatic diversion with duodenal switch and the adjustable gastric band. In the U.S., the laparoscopic Roux-en-Y gastric bypass (LCRYGB) has become the gold standard in bariatric surgery. In Europe the number of gastric bypass procedures is also rapidly increasing. It is interesting that Fobi gastric bypass modification is more popular every year. We decided to describe the surgical complications of banded bypass and on this basis to evoke a controversial discussion. Should we be afraid of the silastic ring? How much we can profit from implantation and what do we have to risk?

Key words: morbid obesity, bariatric surgery, laparoscopy, gastric bypass, banded gastric bypass, GaBP ring.

S owa kluczowe: oty o patologiczna, chirurgia oty o ci, laparoskopia, bypass o dkowy, bypass o dkowy wed ug Fobiego, GaBP ring.

Introduction

While it has been generally agreed that operations should be offered to morbidly obese patients, there is also room for improvement in the traditional surgical treatment of obesity. Is already well known that the different conservative therapies do not stabilize weight long term [1-6]. Surgical treatments offer lots of different therapeutic procedures. Nowadays, gastric bypass is the gold standard in bariatric surgery worldwide [7-9]. The excess body weight loss ranges from 50 to 60% after a gastric bypass procedure in the first postoperative years [9-12]. Unfortunately, long-term follow-up studies showed that the patients regain weight after one year [7, 10, 13-16]. The reason

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for limited long-term weight loss maintenance is unclear, but probably extension of the gastric pouch, gastro-jejunal stoma or the upper small bowel segment plays a crucial part in this phenomenon by increasing absorption [15, 17]. There is a modification of the proximal gastric bypass which uses an old principle to avoid the complication. Using an additional restrictive silastic ring, Fobi and Campella were able to avoid dilation of the gastro-entero anastomosis and adjacent small bowel with subsequent better postoperative weight loss and significantly improved long-term weight maintenance [18-21]. So far, there are no multicentre, prospective randomized studies published comparing banded and conventional gastric bypass. Recently published results concerning banded vs. conventional gastric bypass demonstrated superior long-term treatment success for the banded gastric bypass after 3 years [22]. Fobi and coworkers developed this technique and started with banded gastric bypass in 1998 (publication year) [18-20]. Safety and feasibility have been demonstrated by Fobi et al. in their published series of 50 consecutive patients with an increased excess weight loss of more than 70% and no increased postoperative complications [19]. Other centres have also started to use this new technique, but published experience is limited [21, 22]. The aim of our manuscript was to write about the surgical complications of laparoscopic banded gastric procedures. There are many possible complications after a proximal gastric bypass operation and only very few of them go parallel with the silastic ring. We leave the question of whether or not to have the ring open to discussion.

Operation indications

Where is the place for conventional or banded gastric bypass in bariatric surgery? The general indication with the BMI over 40 kg/m^2 does not answer the question. It is difficult to identify the patient who will best respond to bypass therapy. All patients fulfil the criteria for bariatric surgery as described by the National Institutes of Health Consensus Development Panel in 1991 [23]. There are different types of bariatric algorithms, and in our opinion they could serve as a basis for choosing the optimal operation. The Freiburg Interdisciplinary Metabolic Centre uses modifications of Himpens' schedule [24] where different types of bariatric operations are shown (Figure 1).

Operation technique

The laparoscopic banded gastric bypass (LBRYGB) (Figures 2, 3) technique is used as a standard procedure in our department. We will describe the method briefly to present the differences to conventional gastric bypass.

In the majority of our patients, we perform the operation as a two-surgeon procedure. With the patient in the lithotomic position, and the operating table in a 30 to 40 degree reverse Trendelenburg tilt, the surgeon stands between the patient's legs with one assistant on the left side of the patient. The capnoperitoneum is insufflated with the 12 mm separator trocar (Apply Medical). The residual abdominal pressure is much higher in obese patients (8-10 mm Hg) than in patients of normal weight (2-5 mm Hg). When a pressure of 14 mm Hg is reached, four more work trocars (Figure 4) are placed similarly with the fundoplication positions under direct vision. The subcardiac area is exposed by lifting the left hepatic lobe and pulling down the fundus of the stomach. Using a 30-degree optic (HD Endo-Eye® HDTV, Olympus), we commence exploration of the region of interest. Dissection is started in the region of the angle of His with Ligasure®Advanced (Covidien Valley Lab) just above the first short gastric artery and towards the left crus of the diaphragm. Then we begin the dissection in the region of the small curvature of the stomach, in a perigastric fashion 7-8 cm below the cardia and towards the left crus in order to create the vertical gastric pouch which is based on a lesser curvature. Achieving enough space, 3 to 4 linear Endo-GIA® (Covidien, Auto Suture) 60 mm staplers with blue cartridge are used to completely transect the stomach after the removal of the calibration tube (32 F). This technique enables adequate direct visualization and thus objective evaluation of the anterior and posterior aspects of the pouch and distal stomach for tears, leaks, bleeding, and visual estimation of the pouch size. The cut edge of the proximal pouch and the distal stomach are reinforced with hemoclips (Apply Medical). A GaBP®Ring (Bariatric Solutions) (a pre-manufactured set with a prosthetic auto-locking band and a radiopaque marker made of implant-grade silicone rubber) is placed around the pouch loosely about 2.0 to 2.5 cm from the end point of the pouch. Here it should be mentioned that surgeons most commonly use silastic rings. The silicone bands develop a pseudocapsule

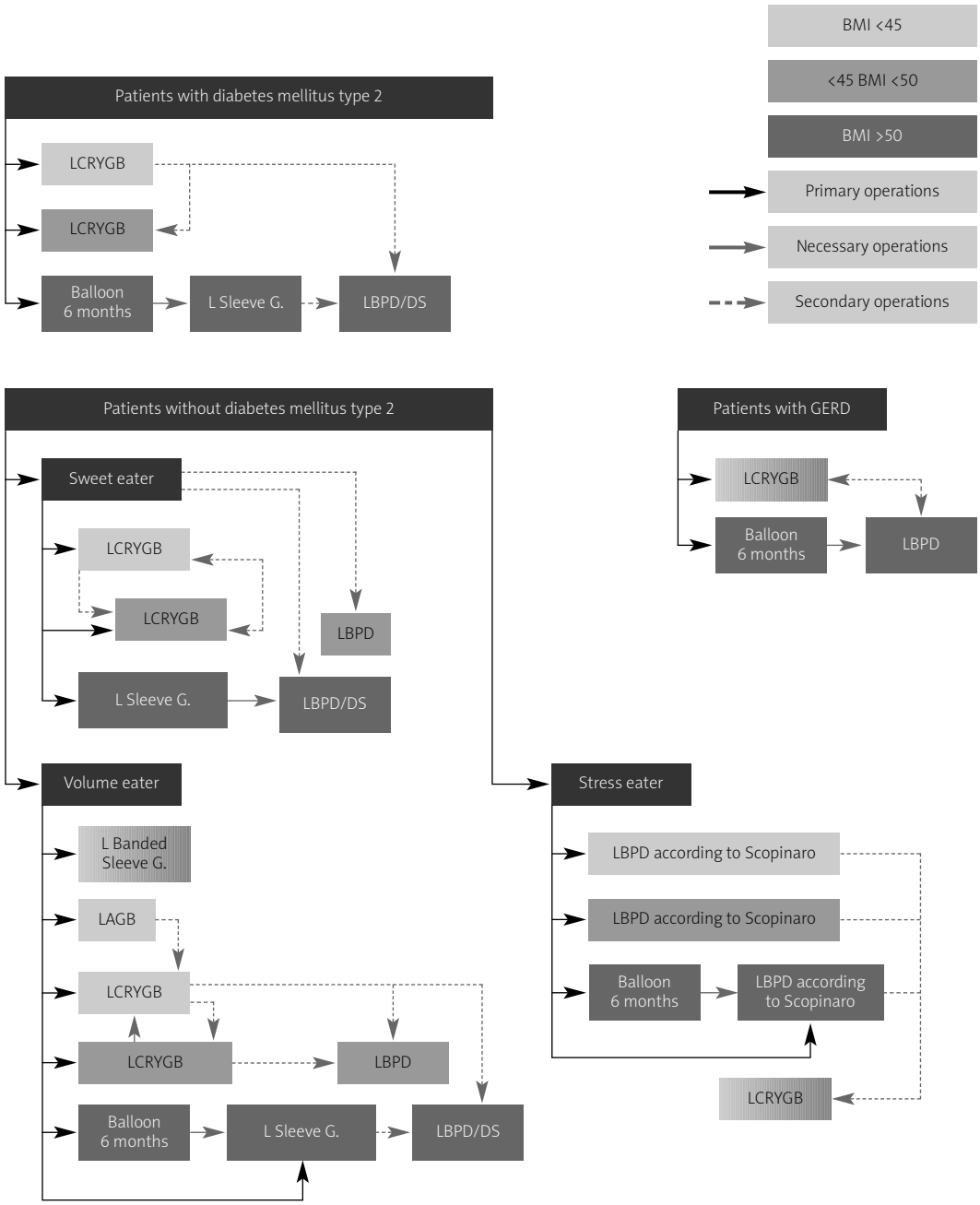

Fig. 1. Our adaptation of Professor J. Himpens' (University of Brussels) bariatric algorithm

which leads to less adhesion and is much easier to remove than other materials. The use of other materials such as linea alba, fascia lata, Gore-tex, Marrlex mesh, Mersilene sutures, porcine and bovine grafts and drains is controversial. The ring size should be 6.0 to 6.5 cm circumference, which has a much better outcome in terms of quality of eating and ring migration than the originally proposed 5.5 cm length.

The position of the ring can be adjusted to increase or reduce the pouch size. The pouch size is usually estimated at 10 to 25 ml. The ring is always fixed with non-resorbable sutures. The surgical technique of vertical banded gastric bypass originally involved a Roux-en-Y limb about 60 cm long and a biliopancreatic limb about 60 cm from the ligament of Treitz. We use an equal length of alimentary (150 cm) and biliodigestive

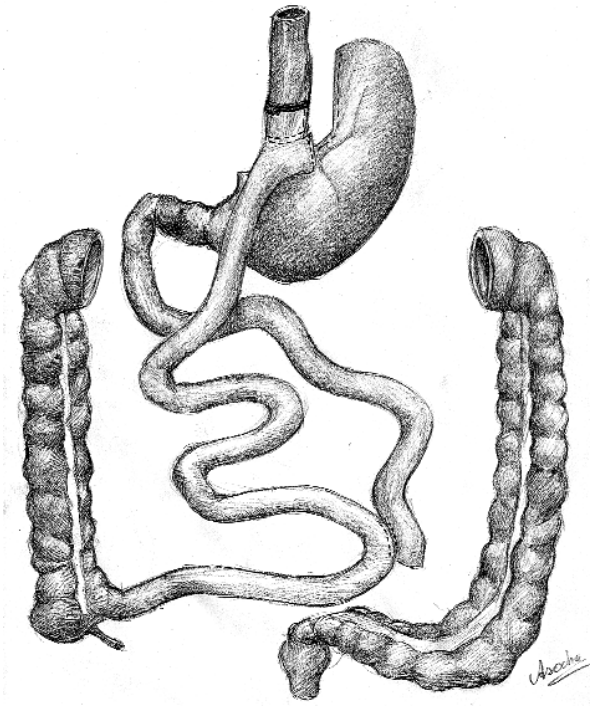

Fig. 2. Schedule® of banded Roux-en-Y gastric bypass (LBRYGB)

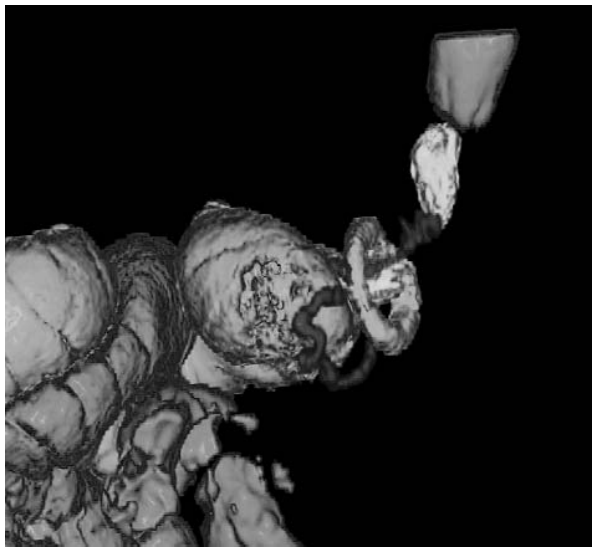

Fig. 3. 3D volume rendering reconstruction of abdominal MSCT of a LBRYGB. Manual and semi-automatic segmentation techniques are applied to show the pouch (cyan), the Roux limb (orange), the oesophagus and intestine (blue), and the staple sutures (red)

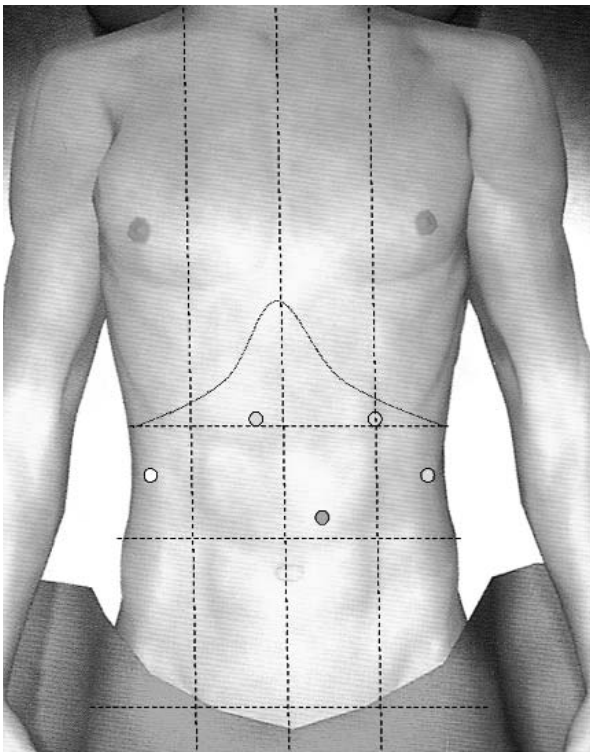

Fig. 4. Schedule of ports placement in laparoscopic banded Roux-en-Y gastric bypass (LBRYGB)

(50 cm) limb as in conventional gastric bypass, which has been performed laparoscopically in our clinic since 1999. This modification allows us to compare the two methods. An alimentary limb of Roux-en-Y is created by dividing the jejunum 50 cm below the ligament of Treitz with a 45-mm Endo-Gia® stapler with white vascular cartridge. Transposition of the jejunal alimentary limb in an antecolic and antegastric position is performed. In patients with an extremely thick and fat greater omentum, additional omentum division is performed with a LigaSure dissector. As the next step, a gastroenteric anastomosis (GEA) is created distal to the band with a hand running the suture end to the side, 2 cm long, with two-layer closure of 2-0/3-0 Vicryl. A 12-mm obturator is used to calibrate the stomal opening. Afterwards, the integrity of the anastomosis is tested for leakage by using methylene blue insufflation through the gastric tube and placement of the bowel clamp on the intestinal limb distal to the anastomosis. A side-to-side stapled jejunojejunostomy is created typically 150 cm below the GEA with one 45-mm Endo-GIA stapler, and the opening for the stapler is closed with a running absorbable suture. Prevention of internal hernias is achieved by closing the gap between the alimentary jejunal limb and

Table I. Operation time and conversions with mortality after LCRYGB in selected series

Published series	Year	No. of patients	Op. time	Op. conversion [%]	Mortality [%]
Schwartz, et al. [60]	2003	600	171	4.2	0
DeMaria, et al. [61]	2002	281	–	2.8	0
Witgrove, Clark [9]	2000	500	90	–	0
Higa, et al. [62]	2001	1500	60	1.3	0.2

transverse mesocolon with interrupted non-absorbable sutures. The area of the GEA is drained with a Blake drain if necessary, and the operation is finished without closure of any abdominal fascial openings.

Early complications

The introduction of laparoscopy reduced the number of surgical postoperative bariatric complications. The overall complication rate ranges from 20 to 40% [25]. Jinxing tried to identify some risk factors of bariatric complications. It is proven that among the most influential factors for predicting major complications are: male gender, revisional surgery, increasing age, obesity with BMI >50 kg/m^2, FEV_1 <80%, previous abdominal procedures and an abnormal ECG [25, 26]. It is well known that laparoscopic bariatric surgery requires advanced skills. Blachar reported complication rates of about 9.5% major and 6.7% minor GI complications as a result of RYGBP, with a mortality rate of 0.4% [27] (Table I). Suture line leaks from 1.2 to 3% are seen at the beginning of the learning curve, which improves with the surgeon's experience [9]. The most common early complications (within 30 days after the surgery) include bleeding, followed by gastric leaks and wound infections. Intra-abdominal abscesses, thromboembolisms, subileus, sepsis, thrombophlebitis, pancreatitis, trocar herniation (Figure 5), dysphagy (Figure 6), and rhabdomyolysis [28, 29] are rarely found.

Anastomotic leakage

The diagnosis of postoperative peritonitis is much more difficult in morbidly obese patients. Physical manual examination is required, but an additional clinical evaluation is necessary in each case. The canon symptoms include tachycardia, incipience of pulmonary insufficiency and worsening of abdominal pain. The diagnostic procedure should be rapidly started with radiological and laboratory examinations.

Fig. 5. Intraoperative picture of port's herniation after LCRYGB operation

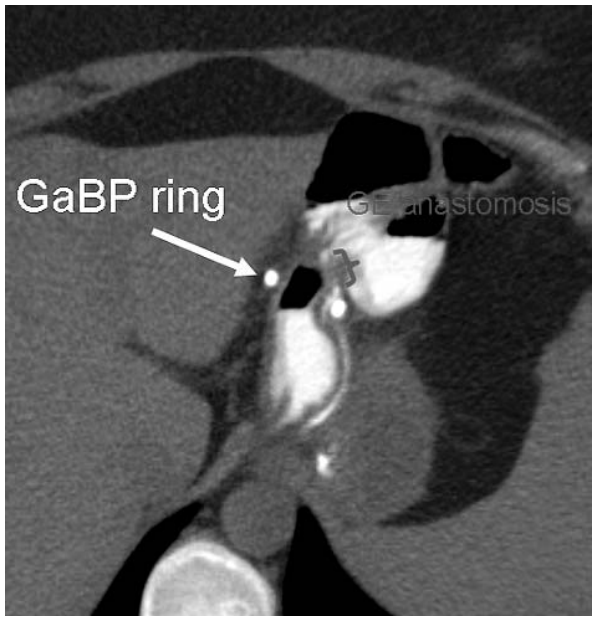

Fig. 6. CT scan of abdominal cavity after LBRYGB with GE anastomosis stenosis after LBRYGB; the ring did not influence stenosis

Anastomotic leakage usually occurs within the first 10 days of surgery. The most common site of the leak is the gastroenteric anastomosis. Because sepsis and bowel obstruction are potential manifestations of an anastomotic leak, CT examination is strongly recommended in all patients with unexplained fever, pain and abdominal distension following RYGB [27]. If it is not possible, the patient should undergo emergency relaparoscopy. This usually allows improvement of the local status and, depending on the intervention time, makes local surgical intervention or drainage of the infected area possible. Some authors insist on performing gastrostomy, which could be used for decompression and later for enteral alimentation of the patient.

Incisional hernias

It has been shown that the incidence of incisional hernias reaches approximately 13.7% of that after open surgery. Port side herniation was reported at the level of 0.5% [9] (Figure 5). We have not observed such complications in our series since we started using the separator trocars.

Thromboembolism

The increased risk for venous thromboembolism in obese individuals has been questioned. In prospective studies using the 125I-fibrinogen uptake test as a diagnostic tool, neither Hills et al. nor Sue-Ling et al. could demonstrate a correlation between obesity and the incidence of postoperative deep vein thrombosis [30, 31]. In a postmortem study of 152 surgical patients by Cullen and Nemeskal, obesity did not seem to be a risk factor for pulmonary embolism, but obesity was not clearly defined. Finally, Flordal et al. evaluated risk factors for thromboembolism in 2,070 patients but failed to prove a correlation between obesity and postoperative thromboembolism. However, all patients had undergone prophylaxis with low-molecular-weight heparin [32, 33].

Gonzalez et al. reported only one popliteal thrombosis in 380 patients with a mean BMI of 48.5 kg/m^2 undergoing laparoscopic Roux-en-Y gastric bypass. Intermittent pneumatic calf compression was used in this study, but no pharmacological prophylaxis [34]. In a registry including 3,097 patients undergoing bariatric surgery, 15 patients died within 6 months after surgery. Pulmonary embolism was the cause of death in 13% [35]. But in 10 autopsies of patients who died after bariatric surgery, pulmonary embolism was the cause of death in 30%, and microscopic evidence of pulmonary embolism was found in 8/10 patients, reflecting the difficulties in correctly diagnosing venous thromboembolism in any patient and even more in the very obese [36]. In a review, Rocha et al. found 11 studies supporting the hypothesis that obese patients undergoing bariatric surgery have an increased risk of venous thromboembolism, and only 2 studies disputing this association. They came to the conclusion that the risk of venous thromboembolism exceeds the risk due to the surgical procedure alone in these patients [37]. A 0.21% rate of fatal pulmonary embolism was detected in a retrospective analysis of 5,554 patients undergoing bariatric surgery in a 24-year period [38]. The cofactors most commonly associated with an increased risk of venous thromboembolism were venous stasis disease, a BMI of more than 60 kg/m^2, truncal obesity, and obstructive sleep apnoea.

To date, eight studies have been published addressing the efficacy of venous thromboembolism prophylaxis, especially in patients undergoing bariatric surgery. In a retrospective study at 5 centres of 668 obese patients receiving 30 or 40 mg of enoxaparin once or twice daily, 6 (0.9 %) cases of pulmonary embolism were documented by objective testing, and 1 (1%) deep vein thrombosis. This is a low incidence – but virtually all pulmonary emboli derive from deep vein thrombosis, whereas only 25% of deep vein thromboses lead to pulmonary embolism [39]. So a lot of deep vein thrombosis episodes must have been missed in this study, again demonstrating the difficulty in correctly diagnosing deep vein thrombosis in obese patients.

GE anastomosis stenosis

The gastroenteric (GE) anastomosis that drains the stomach pouch into the gastric bypass is intentionally small. Larger stomas are not associated with adequate weight loss. As a consequence, stomal stenosis is relatively common (Figure 6). Patients develop dysphagy, vomiting, satiety, upper abdominal pain and gastro-oesophageal reflux in the early postoperative period. The incidence of this complication is directly related to the GE anastomosis technique (round staple, linear staple, hand-anastomosis). The therapy of GE stenosis is based on common endoscopic dilation and very seldom is there need for re-anastomosis [28, 29].

Regurgitation and oesophagitis

The incidence of regurgitation and the quality of eating is closely related to the ring size. Stubbs et al. reported that in 18% major restriction in the quality of eating occurred in a group of patients treated with a 5.5 cm ring, whereas in the groups with 6.0 and 6.5 cm rings only 8 and 4% had similar problems. Regurgitation occurred more than three times a week in 29% in the first group with 5.5 cm and in only 14% in the last ones. The risk of developing chronic regurgitation is related to two independent factors, namely lower oesophageal sphincter function and the size of the silicone ring placed around the gastric pouch. The smaller the ring, the more frequent the chronic regurgitation [17, 18, 20, 21]. We therefore advise using rings of at least 6.5 cm length and 7.0 cm in revisional operations. Hypotonia of the lower oesophageal sphincter (the normal value is 14-34 mm Hg) increases the risk of becoming a chronic regurgitator. The chance is seven times greater than for patients with normal lower oesophagus sphincter pressure.

The LES pressure can be measured by oesophageal manometry. In our opinion, this should be done routinely prior to bariatric surgery for the purpose of planning the operation type. Both LES hypotonia and small band diameter increase the risk of frequent regurgitation. Patients with low LES pressure should not undergo banded gastric bypass but another bariatric procedure, such as conventional RYGB or BPD [21]. Sometimes esophagitis is diagnosed postoperatively, but there is no relation between LES pressure and the ring size or chronic regurgitation [40, 41].

Late complications

Gastrogastric fistulas

Salinas et al. reported that the incidence of gastrogastric fistulas in patients with a completely transected stomach reached 8.5%. Stubbs et al., who performed BRYGB without complete transection of the stomach, found a staple line disruption rate of 7.9%, whereas the groups that divided the gastric pouch from the bypassed stomach by transecting it did not find comparable incidence of this problem [41]. Nowadays, gastrogastric fistulas are rare because of operative technique changes. The incidence increases with the patient's BMI. In our material, we found two fistulas in patients who gained weight rapidly. We could not observe either of them endoscopically because of incomplete gastroscope inversion movement, but CT diagnostics showed the connection between the pouch and the remnant stomach (Figures 7-9).

Ring-related complications and proposed therapy

The main reason for the greater popularity of conventional bypass compared to BRYGB is the foreign body which has to be implanted in the banded version. Band erosion or migration into the gastric lumen after banded gastric bypass seems to be a rather rare late complication. Most authors reported an incidence around 0.5%. Studies with larger patient groups report a band erosion rate of 1.63% (48 of 2,949 patients). The erosion incidence was lower (0.92%) in primary operations. The following clinical symptoms appeared along with the pathology: weight regain (37.5%), stenosis or obstruction (35.4%), pain (18.75%), bleeding (14.58%). 89.5% of patients lost the band [41]. In a 10-year observation of banded gastric bypass, Barroso showed: 26 stenoses, 9 erosions, 2 spontaneous eliminations, 3 slippages, and two openings of the ring [43].

Fig. 7. 3D volume rendering reconstruction of abdominal MSCT showing the gastro-gastric fistula. Manual and semi-automatic segmentation techniques are applied to show the pouch (green), the Roux limb (orange), the remnant stomach (blue), and the staple sutures (red)

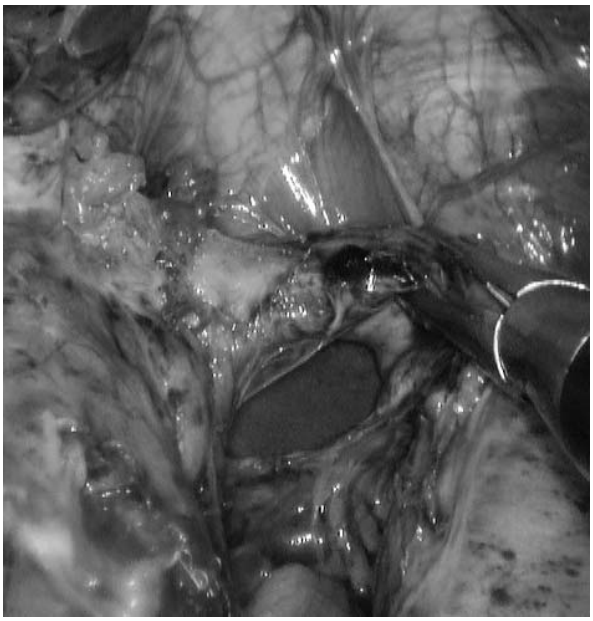

Fig. 8. Intraoperative picture of the gastro-gastric fistula

Fig. 9. Gastro-gastric fistula preparation. In the fistula's lumen scissors, Kocher's forceps show the end of primary stapler suturing

The other very large group observed in the Elias study presented 125 band explanations in 138 medical band-related events [44]. A band could be removed spontaneously through migration, per endoscopy, per laparoscopy or rarely by laparotomy. Some possible causes of band erosion are cited, such as: constriction of the band, suturing of the band to the stomach, imbrication of the band with the stomach, and infection. Fobi proposed the mechanism of BE, with the first step usually being inflammation between the stomach wall and the band, leading to band extrusion into the pouch lumen through stitch abscess formation and extrusion of the stitch. Afterwards, a dense fibrous reaction appears around the banded pouch [15, 41].

Removal of the ring is combined with significant weight gain [43]. Appreciable weight regain occurred in 43.75% of patients who underwent band removal, with an average of 14% of excess weight loss (EWL) regained. Primary replacement of the band is not recommended. As therapy guidelines, Fobi proposed: for asymptomatic patients the treatment can be waiting for spontaneous extrusion of the band and proton pump inhibitors (PPI) or H2-blockers. The management of choice is endoscopic removal of the band. After the removal, these patients are treated with PPI or H2-blockers and are monitored for 24 hours without oral intake for symptoms of leakage or bleeding. After 24 hours, an upper GI series can be done to rule out a leak. If endoscopic removal is not feasible, which is especially the case if materials other than a silastic ring, such as non-absorbable sutures, were used, the band can be removed by a laparoscopic operation with intraoperative endoscopy [45]. After laparoscopically performed RYGB, the erosion of non-dissolvable material, such as Peri-Strips or silk sutures, into the gastric pouch can occur. The most common presenting symptoms are abdominal pain, nausea, vomiting, dysphagia, and melena. The management of choice is therapeutic endoscopy, which will resolve most of the upper GI symptoms. Yu et al. have shown that the use of Vicryl sutures and Seamguard will avoid foreign material erosion [46].

Internal hernia

In contrast to open surgery, small bowel obstruction after laparoscopic surgery is more likely to be caused by an internal hernia rather than by adhesions. Usually, the small bowel herniates through an abnormal aperture within the peritoneal cavity [47]. The most common internal locations include Petersen's space as the area between the mesentery of the alimentary Roux limb and the transverse mesocolon, a mesenteric defect at the jejunojejunostomy (Figure 10), and in case of a retrocolic Roux limb, a transverse mesocolon defect [48]. The incidence of internal hernia after Roux-en-Y gastric bypass has been reported as less than 1% and up to 4.5% in large series, with the retrocolic approach

being associated with significantly higher internal hernia rates due to three defects which are created compared to two defects in the currently more favoured antecolic reconstruction [48-50]. Exact location of internal hernia varies with the surgeon's preference of either retrocolic or antecolic Roux limb.

In their large series of more than 1,000 lap-RYGB procedures, Garza et al. reported the most common clinical symptoms as intermittent, postprandial abdominal pain (88%) and/or nausea and vomiting (65%) with mean duration of symptoms of 16 days. Mean time from first operation to intervention was 225 days. The location of abdominal pain seemed to correlate with the side of internal herniation [48]. Paroz et al. describe very similar symptoms with a mean occurrence at 29 months post-operation and a mean weight loss of over 14 BMI units [51]. We have observed similar results in our patients. Mostly the cases were associated with atypical abdominal pain, not as a postprandial event. All of the patients were reoperated because of internal hernia more than a year after the primary procedure. Except in the acute setting of small bowel obstruction, the exact diagnosis is hard to define. CT scan examination of the abdomen and the pelvis should be performed with both oral and intravenous contrast. Abnormal clusters of bowel loops were shown to be the best predictors of internal hernia. Small bowel loops in the left or right upper quadrant, evidence of small bowel mesentery traversing the transverse colon mesentery and/or location of the jejunojejunostomy above the transverse colon are suggestive of internal hernia. In addition, crowding, stretching and engorgement of the main mesenteric trunk to the right may be seen [48]. But one should not forget the limited diagnostic reliability. Higa et al. presented 20% negative CT scans in patients with proven internal hernia, and furthermore Garza et al. showed only 64% positive CT scans in patients with internal hernia [48, 50]. This is the reason why it is suggested to perform diagnostic laparoscopy in patients with atypical abdominal pain when it is not possible to find the cause of the tenderness, to ensure the diagnosis and to avoid further complications. In our material a negative CT scan examination with the herniation is even higher and reached 50%. This inaccuracy is likely to be caused by the inexperience of radiologists diagnosing internal hernias. Regarding the mean timeframes until diagnosis mentioned above, surgeons must be very suspicious of postoperative internal hernias irrespective of the interval after surgery. To improve the results and reduce the surgical reintervention, it is obligatory to carefully close each aperture created in the primary procedure. The surgeon has to improve the Petersen space and mesenterium by entero-entero anastomosis and when necessary close it with nonresorbable sutures in all patients who undergo abdominal operations also for other reasons as well.

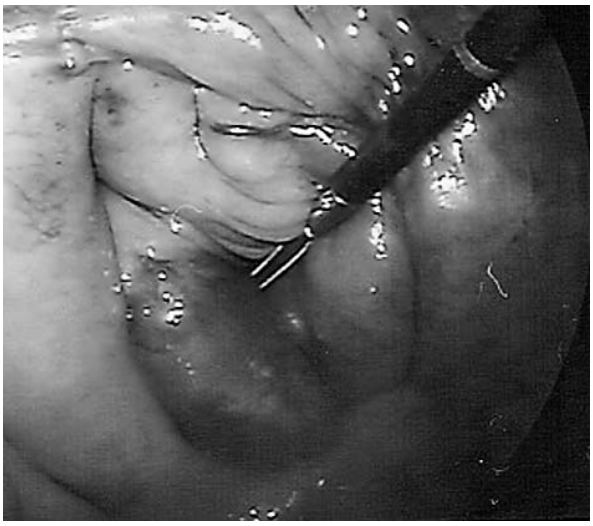

Fig. 10. Intraoperative photo of jejunojejunal anastomosis space one year after laparoscopic conventional Roux-en-Y gastric bypass (LCRYGB)

In reoperations, only very few patients need an open approach, so mostly it remains a less invasive procedure requiring 1 to 4 days of hospital stay [48]. All defects should be repaired by nonabsorbable, preferentially running sutures [51]. Other abdominal hernias should be operated with general indications and techniques, giving preference to less invasive procedures (Table II).

Weight loss differences

The influence of the silastic ring on the percentage of excess weight loss within the first year was between 81.3 [52] and 73.5 [41]. After two years, the percentage was around 80%, and at 5 years follow-up an EWL of about 75% could be found. The comparison with other studies of EWL by laparoscopic conventional Roux-en-Y gastric bypass (LCRYGB) reviewed systematically showed better results with LBRYGB. Only a slight weight regain of 2.5% (41) or 5% is observed between the second and fifth postoperative year [53], whereas a weight regain for LCRYGB of over 10% in the same

Table II. Complications after LCRYGB in selected series

Series	Leaks [%]	GI bleeding [%]	DVT [%]	Ileus [%]	Stricture [%]	Incisional hernia [%]	Wound infection
Schwartz, et al. [60]	0.8	0.8	–	0	4	–	–
DeMaria, et al. [61]	5	–	–	1.4	6.4	1.8	1.1
Wittgrove, Clark [9]	2.2	0	–	0.6	1.6	0	4.2
Higa, et al. [62]	1.0	–	0.2	0.2	4.9	0.3	0.1

period is reported. The EWL after conventional GB reached 58.2% after five years in the best series [10].

Jorge et al. reported that the average EWL was 67.6±14.9% in the first postoperative year, 72.6±14.9% in the second year, and 67.9±15.1% in the fifth postoperative year. Surgical treatment failure (defined as <50% EWL) occurred in only 12 patients (6.5%) during the 5-year follow-up [54]. Bessler performed the first prospective study to directly compare the two operation methods. He showed advantages for banded gastric bypass in the early stage [22]. As known, multicentre studies comparing these two operating methods were started in parallel on all continents.

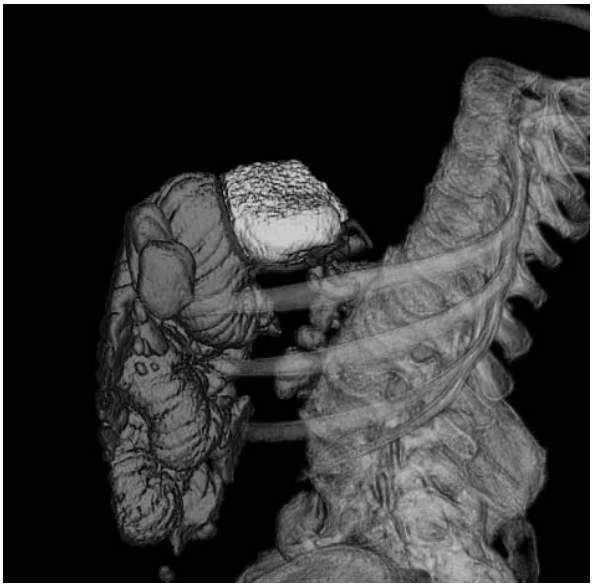

Fig. 11. 3D volume rendering reconstruction of abdominal MSCT showing a dilatation of the stomach pouch (51 cm^3) and GE anastomosis (diameter 3.4 cm, area 10.1 cm^2). Manual and semi-automatic segmentation techniques are applied to show the pouch (green), the Roux limb (orange), and the staple sutures (red)

Banded gastric bypass produces similar weight control as BPD and BPD-DS, with lower incidence of subsequent biliopancreatic diversion disadvantages such as diarrhoea, gas bloat syndrome, protein malnutrition, foul body odour, stool odour, and flatus [19]. Patients with the BRYGB followed for a period of over 7 years had a revision rate under 6% [21].

Where is the problem with conventional bypass 12 months after conventional Roux-en-Y gastric bypass, a great number of patients report a loss of postprandial satiety and have a dilated gastrojejunostomy (Figure 11). Roberts et al. have observed a negative correlation between pouch size and weight loss 6 and 12 months after operation. In each of the described surgical procedures, the creation of an appropriate gastric pouch is needed to achieve satisfactory results [55]. Krawczykowski found that the stomach volume strongly influenced the weight reduction after BPD [56]. If an insufficient loss of weight or even a regain of weight occurs, it is crucial to assess whether there is still sufficient restriction. In case of insufficient restriction, a re-operation might be necessary. The precise volume and anastomosis area estimation allows the surgeon to choose the better redo surgery strategy and to select the best operative option for the patients. It is proven that GE anastomosis is responsible for gaining weight. Endoscopic suturing to tighten dilated gastrojejunal anastomosis is technically feasible and safe, and may lead to weight loss for certain patients [57]. Another logical therapy option is implantation of the GaBP Ring as a redo procedure which switches the conventional to banded bypass (Figure 1) [58, 24]. An analogous procedure with additional gastric banding to the Roux-en-Y GB was also proposed by Bessler et al. [59] (Table III).

Conclusions

We recommend the LBRYGB for patients with a BMI above 45 but below 50 kg/m^2 with sweet- or volume

Table III. % EWL and BMI after banded gastric bypass in selected series

Series	% EWL after 1 year	BMI after 1 year	% EWL after 2 years	BMI after 2 years	% EWL after 5 years	BMI after 5 years
Capella, et al. [45]	–	–	–	–	76.3	29
Zorrilla, et al. [52]	81.3	26.2	–	–	–	–
Fobi, et al. [21]	73.5	–	78.2	–	75.7	–
Stubbs, et al. [41]	88.6	28.9	90	28.1	80.8	29.6
Vigo, et al. [53]	76	–	80	–	75	–

eating disorder. LCRYGB or BPD should be performed in patients with a pre-operative gastro-oesophageal reflux disease.

The evolution from the band to the silicone ring was observed in both vertical banded gastroplasty and banded gastric bypass. The silicone band develops a pseudocapsule which leads to less adhesion, and is much easier to remove than the silicone ring. Besides its restrictive role, it contributes to the reduction of undesirable side-effects such as dumping syndrome and foul flatulence. The banded bypass causes satiety and reduces caloric intake, through retarding gastric emptying and inducing the satiation sensation even with low food intake. After the second or third postoperative year, the patient seems to adapt to the surgery and to suffer its side-effects in lower intensity, which brings a tendency for some recovery of lost weight. But weight gain is very slight compared to the conventional gastric bypass.

The new manufactured goods, including "ready for implantation" rings such as GaBP, make the procedure standardised. The time for GaBP ring placement ranged from 2 to 5 min in the open cases (average 3 min) and from 3 to 11 min in the laparoscopy cases (average 5.6 min). The new product needs to be improved to reduce premature separation system of the introducer form and the GaBP ring in the passage through the lesser omentum and to develop an easier closing system allowing faster implantation.

Generally, the introduction of the silastic ring has reduced ring-related complications. The general bypass complications are on the same level as for the banded bypass. The ring-related complications are not associated with lethal complications. The easy switch between those two operations and better weight reduction results will probably influence the number of banded bypass procedures performed as primary and secondary operations.

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