Original Article

Primary non-closure of mesenteric defects in laparoscopic Roux-en-Y Gastric Bypass – Reoperations and intraoperative findings in 146 patients

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Abstract

Background:

Internal hernia's (IH) after laparoscopic Roux-en-Y gastric bypass (LRYGB) have been reported with an incidence of 11%. IH can lead to bowel incarceration and potentially bowel necrosis. The aim of this study was to analyse reoperations and intraoperative findings in a cohort of patients with unclosed mesenteric defects.

Methods:

From a prospective database of patients with LRYGB we selected as primary cohort patients with non-closure of mesenteric defects and abdominal reoperation for analysis. The data included pre-, intra- and postoperative findings, computed tomogram results and laboratory test results. This group underwent a very very long limb LRYGB (VVLL-LRYGB), at that time the institutional standard technique. Additionally, a more recently operated cohort with primary closure of mesenteric defects was also analysed.

Results:

We identified 146 patients with primary non-closure and reoperation, mean age of 43.8 years. The main indication for reoperation was unclear abdominal pain in 119 patients with 27 patients undergoing a reoperation for other reasons (weight regain, prophylactic surgical inspection of mesenteric defects). Median time and mean excess weight loss from RYGB to reoperation were 41.1 months and 62.7%, respectively. The incidence of IH was 14.4%, with all patients with an IH being symptomatic. Conversion rate from laparoscopic to open surgery was 5.5%, mortality 0.7% and

morbidity 3.4%. 31 patients underwent a second re-look laparoscopy. 11 patients had recurrent open mesenteric defects. 316 patients who underwent primary closure of the mesenteric defects had a reoperation rate of 13.6% and an IH rate of 0.6%.

Conclusion:

The incidence of IH in patients without closure of mesenteric defects and reoperation is high, and substantially higher compared to patients with primary closure of mesenteric defects. Patients with or without closure of mesenteric defects following LRYGB with acute, chronic or recurrent pain should be referred to a bariatric surgeon for diagnostic laparoscopy.

Key Words:

Internal hernia; Roux-en-Y Gastric Bypass; Mesenteric defects; Bariatric Surgery.

Introduction

Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) is still the most common surgical procedure for the treatment of morbid obesity. It has been shown to be an effective method with a reported excess weight loss (EWL) of 60-70% over 10 years[1-3]. According to recent epidemiologic data 348'000 bariatric procedures were performed worldwide in 2011, most of which were LRYGB[4]. LRYGB is considered by many bariatric surgeons as the gold standard in bariatric surgery[5-7] however, the technique is not standardised and many variations exist. Limb lengths, gastro-enteric anastomotic techniques such as hand sewn, linear or circular stapled as well as ante-colic or retro-colic positioning of the Roux limb vary between centres and surgeons. One of the more debated issues is the necessity to close the several potential mesenteric defects. Due to the rapidly increasing number of LRYGB, not only bariatric surgeons but also other surgeons with less experience in bariatric surgery are confronted with patients suffering from abdominal problems after LRYGB. One of the more significant mid- to long-term complications that may arise after RYGB is an incarcerated internal hernia (IH). Incarceration of small bowel may result in bowel ischemia, and potential necrosis. IH remains a major cause of late complications with a reported incidence of 0.5% to 11% and is thought to be higher in patients undergoing a laparoscopic versus to the open approach.[8-11]. IH's are the most frequent cause for small bowel obstruction (SBO) after LRYGB[12]. Potential surgical defects which can lead to IH formation are the transverse mesocolon that is opened in the retro-colic Roux limb positioning technique, Petersen's space that represents an opening between the transverse mesocolon and the Roux limb mesentery, the jejuno-jejunal or jejuno-ileal mesenteric defects and finally at the suture of the two small bowel loops (bilio-pancreatic and Roux limb)[13-18]. In patients with acute abdominal pain after LRYGB a high suspicion of potential IH must be present. However, symptoms of IH are often nonspecific and

patients may present with acute, chronic or recurrent pain and transient incarceration symptoms may resolve spontaneously[19]. A computed tomography (CT) scan is often the imaging modality of choice, however, CT scanning has a low sensitivity to detect IH and often diagnostic laparoscopy is performed to exclude suspected IH[14].

The literature concerning mesenteric defect closure is scarce and patient numbers in published articles are generally low. Furthermore, most papers present only short-term follow-up for a complication that may occur years after primary RYGB surgery[16;20-22]. Hence, the aim of our study was to analyse clinical, imaging and intraoperative findings in patients that underwent elective or acute surgical closure of mesenteric defects following primary LRYGB.

Patients and Methods

In 2000 LRYGB was established as the preferred surgical procedure for the treatment of morbid obesity at our institution. The mesenteric defects were left open until November 2008 until detection of an increased IH's frequency and the death of one patient due to SBO. After this, routine closure of all mesenteric defects occurred. Patient selection criteria for bariatric surgery was per the Swiss national guidelines consisting of at least two years of failed conservative treatment, a body mass index (BMI) of 35kg/m² with obesity related comorbidities or a BMI of 40kg/m² without related comorbidities. In 2011 the national guidelines were modified and a BMI 35 kg/m² without comorbidities was accepted as the threshold for bariatric surgery. An interdisciplinary team consisting of psychiatrists, dieticians, gastroenterologists and bariatric surgeons evaluated all patients. After fulfilling the guideline criteria and an interdisciplinary consensus, surgical therapy was initiated.

Data collection

From 2000 onwards, demographic and intra- and postoperative data of all bariatric surgical procedures at our institution were prospectively entered in a database (Excel Microsoft). For this study, all LRYGB patients with non-closure of mesenteric defects who underwent elective or emergency re-operations were reviewed. Outcome parameters were as follows: patient demographics, EWL, clinical symptoms, computed tomography findings at presentation, intraoperative findings, morbidity and mortality. A consultant bariatric surgeon and consultant radiologist, respectively, independently analyzed the available computed tomography scans for signs of IH. Intraoperative findings were collected from the operative notes. IH definition was based on small bowel herniation through one of the mesenteric defects present at the time of re-operation requiring reduction of the hernia followed by mesenteric defect

closure. The study was approved by the local ethics committee of the State of Zurich, Switzerland.

Surgical Technique

The standard technique at our institution until November 2008 consisted of a very very long limb LRYGB (VVLL-LRYGB). This included the creation of a small gastric pouch, an omental split to lower the tension at the gastro-enterostomy, ante-colic positioning of the Roux limb, left orientation of the Roux limb at the site of the gastro-enterostomy, a bilio-pancreatic limb (BPL) with a length of 50cm and positioning to the left of the Roux limb. The common channel (CC) length was 100cm without routine closure of the resulting mesenteric defects. In VVLL-LRYGB the CC is measured from the ileocecal junction running proximally and the biliopancreatic limb from the ligament of Treitz running distally. The length of the Roux limb was not measured. From November 2008 onwards, the mesenteric defects were routinely closed with non-absorbable interrupted sutures (Prolene® 3-0) following LRYGB. In addition, we have changed our technique from VVLL-LRYGB to a proximal LRYGB (PLRYGB) during 2010. After that VVLL-LRYGB was preferred in selected cases either for revisions after weight loss failure or in super-obese patients. Patients with VVLL-LRYGB and non-closure mesenteric defects at the time of the primary LRYGB were included in our analysis.

Emergency re-operations occurred in patients with peritonitis, suspicion of bowel ischemia, unresolved pain or present features of IH on computed tomography. In cases of chronic recurrent abdominal pain semi urgent elective surgery was planned. Initially, diagnostic laparoscopy was performed, but in cases of abdominal distension, significant adhesions, non-reducible hernias and bowel necrosis conversion to laparotomy was performed.

Intra-abdominal inspection included all previous port sites, Petersen's and the meso-jejunal mesenteric defects. IH's were reduced, and closed with interrupted sutures (absorbable and non-absorbable). Furthermore, all defects found open at the time of reoperation were closed using the same technique. All operations were either performed or under supervision of an experienced bariatric surgeon.

Statistical analysis

Statistical analysis was performed with MedCalc®, Version 9 for Windows. Data are presented as medians with 95 % confidence interval or mean with standard deviation (SD) as appropriate.

Results

Baseline characteristics and indication for surgery

585 laparoscopic RYGB were performed at our institution during the study period 2000 to 2013. 269 Patients with non-closure of the mesenteric defects and 316 with primary closure of mesenteric defects (77 with VVLL-LRYGB and 239 with PLRYGB) were identified. 146 patients (59.3%) with open mesenteric defects had re-operations at our institution and represented the main cohort for analysis. 101 patients (37.5%) did not undergo any further reoperations and were not further analyzed. Furthermore, 22 (8.2%) patients with left open mesenteric defects were lost to follow-up. The mean follow up time of patients with open mesenteric defects was 81 months. The baseline characteristics of the re-operated 146 patients are shown in table 1. The indications for the reoperation were unclear pain (119), weight regain (6), steatorrhoea (1), and malabsorption (2). Furthermore, the mesenteric defects were closed in 18 asymptomatic patients due to patients' wish. Three late deaths in the non-operated group occurred - one sepsis with renal failure, one osteomyelitis of the spine, and one patient with an IH and extensive bowel necrosis detected at autopsy.

Intraoperative findings

IH's in the re-operated group were present in 21 patients (14.4%), with 13 Petersen's hernias and 8 meso-jejunal hernias. One patient had both. A total number of 22 IH's occurred in patients with open mesenteric defects (21 in the reoperated group and 1 in non-reoperated) thus the incidence of IH with open mesenteric defects was 8.9%.

In 138 patients the operation was finished laparoscopically. Conversion to laparotomy was needed in 8 patients. The detailed intraoperative findings are listed in table 3.

Preoperative laboratory and CT findings

In 4 (19%) patients with IH the laboratory parameters were elevated whereas in 17 (81%) patients no elevation of inflammatory markers was seen despite presence of an IH.

Preoperative CT scanning was performed in 48 patients with unclear abdominal pain. The CT scan demonstrated pathological findings in 18 (38%) patients with a normal scan in in 30 (62%) patients. (Table 2).

Of the 21 patients with intraoperatively confirmed IH, 14 (67%) had preoperative CT scans with 11 (79%) demonstrating radiological signs of IH. (Table 4).

Postoperative morbidity and mortality

Early surgical morbidity (3%) consisted of 1 cystic stump leak after concomitant cholecystectomy, 1 wound infection and 3 SBO's due to kinking at the entero-enterostomy. One patient died of ischaemic bowel and associated sepsis due to a strangulated meso-jejunal hernia.

Follow up after re-operation

Length of follow-up after re-operation was 32.6 (±21.2) months. During that time 31 of the re-operated patients underwent another operation due to recurrent pain (29) or weight regain (2) leading to a revisional-operation rate of 12.6% based on the total of patients with primary non-closure of mesenteric defects and available follow-up. In 11 patients the closed mesenteric defects had reopened. 5 in the Petersen's space, 3 at the meso-jejunal space and in 3 at both locations. The initial closure technique in 5 of these patients was done with absorbable suture material (PDS® 3-0) and in 6 patients with non-absorbable suture material (Prolene® 3-0). Other intraoperative findings were adhesions (6), trocar hernia (2), incisional hernia (2), invagination at the entero-enterostomy (2), gallstones (1), sigmoid volvulus (1) and a teratoma of the ovary.

IH's in patients with primarily closed mesenteric defects

Of 316 patients with primary closure of mesenteric defects, 43 (13.6%) patients had reoperations since the adoption of complete defect closure into our standard technique in 2008. 2 (0.6%) IH's were identified at the time of reoperation. Both hernias were found at Petersen's space. The meso-jejunal defect was closed in both patients with IH at reoperation. The meso-jejunal space appeared closed in 32 (74.4%) of reoperated patients and the Petersen's space in 28 (65.1%). 35 (11.1%) patients had reoperations due to pain, 6 (1.8%) due to weight loss failure, 2 (0.6%) due to abdominal wall hernias.

Discussion

LRYGB is the most frequently performed bariatric procedure worldwide and has become the preferred approach due to its advantages in the early postoperative course[23]. The initial description of LRYGB did not include closure of the mesenteric defects, which runs the risk of SBO due to IH. However, IH was a very rare complication in the era of open bariatric surgery[24]. Recent reports of SBO due to IH following LRYGB have triggered discussion as too whether the closure of mesenteric defects needs to become the standard of care in laparoscopic RYGB or not [25-28].

The results of our study show an IH rate of 14.4% in re-operated patients and thus we would advocate routine closure of all mesenteric defects at time of primary LRYGB. This incidence is slightly higher than previously reported[5;9-11;13;16;20;29]. The analyzed cohort included only patients with non-closure and a reoperation. Therefore, the incidence of IH can be considered as the true incidence, as diagnostic laparoscopy by an experienced surgeon should have a sensitivity of detecting an IH of 100%.

The application of a malabsorptive LRYGB with a short CC is a less common alternative technique but taking the known risk of long-term weight loss failure into account and it is used by other bariatric surgeons [30-33]. It remained our standard LRYGB technique until 2010 after we changed to a PLRYGB, thereafter choosing VVLL-LRYGB only in selected cases such as super-obese patients or previous weight loss failure. Despite the fact that the nowadays mainly used technique is the proximal RYGB, the mesenteric defects stay similar, with different sizes according to limb lengths, and our findings concerning IH are thus applicable for all different bypass techniques. Still, one might consider this as a potential limitation.

The malabsorptive LRYGB technique in our cohort consisted of a VVLL-RYGB which has a long Roux limb and a short common channel thus creating a greater meso-

jejunal defect than in short-limb LRYGB. The size of Petersen's space remains similar compared to short limb LRYGBs. This may be argued as one possible cause for the increased incidence of IH in our group. Conversely, our study reports 146 patients with non-closure of mesenteric defects following LRYGB who underwent a re-operation and inspection of the mesenteric defects. Thus, the incidence of IH in our data can be devised more accurately offering a true natural course after non-closure. In addition, the incidence of IH seems to increase with longer observation periods therefore the higher incidence in our cohort may be due to the long follow up period we observed. The mean follow up time was 81 months which is longer than in most of the previously reported studies[9-11]. CT scanning may show IH, but 20% of patients in our cohort who had intraoperatively confirmed IH showed no pathologic signs on preoperative CT scans. Similarly, laboratory results are not reliable enough to exclude IH, indicating that diagnostic laparoscopy is the best investigative tool for IH.

The proportion of re-operated patients (59.3%) in our cohort is unusually high. The reason for our increased reoperation rate is based on our protocol that consists of a diagnostic laparoscopy in every patient with unclear abdominal pain and the recall of patients with left open defects in order to perform a secondary prophylactic closure.

Until the beginning of 2008 we did not perform routine defect closure. After the death of a LRYGB patient from ischemic small bowel from an IH we changed our routine surgical technique to mandatory closure of all the defects. Our institutional experience and the increasing number of reports advising complete closure of mesenteric defects led to that change of our protocol. From 2008 on we also offered all patients with previous non-closure of the defects a prophylactic diagnostic laparoscopy, even in an asymptomatic state, and closure of the defects. They were recalled by phone or mail in order to advise them of the possible consequences of IH formation. 16 patients agreed to perform the diagnostic laparoscopy even though they were asymptomatic.

Overall, mesenteric defects were not closed in 269 patients. Of these, 119 patients experienced intermittent or persistent abdominal pain that led to re-operation. All patients with IH (21) had abdominal pain. 14 patients showed other reasons for pain. This leaves 84 patients where open mesenteric defects with possible intermittent IH not detectable at the time of reoperation could be the possible cause of symptoms. We closed all defects regardless of the intraoperative findings when open defects where found. In symptomatic patients, it is still unclear whether the Peterson's or the meso-jejunal defects are the cause of pain. As we either closed both defects or none, the present study cannot analyze the defect type separately. Also, whether the pain was exclusively caused by IH, or other causes are difficult to differentiate. In VVLL-LRYGB the Peterson's defect roughly has the same size as in PLRYGB, but the meso-jejunal space is larger and more difficult to close. Large defects may prevent strangulation. Still, a large defect may lead to herniation of a large bowel segment and subsequent strangulation. In contrast to colorectal surgery, e.g. sigmoid resection, where defects are usually not closed, the area where the dissection has been performed is smaller in patients with LRYGB. Thus, the tendency for spontaneous closure of defects after bariatric surgery might therefore be lower.

We did not perform a structured pain assessment with the patients in our cohort prior and after reoperations. However, in patients with unclear pain after LRYGB and open mesenteric defects one needs to consider an IH and act appropriately in order to prevent potential morbidity and mortality. In our opinion, diagnostic laparoscopy is the method of choice, allowing intervention if pathology is found. Most papers reporting on IH have a very short follow up period [8;16;22;28]. Late occurrence combined with an asymptomatic IH might lead to an underestimation of the true IH incidence.

Our median follow up period was 81 months thus potentially leading to a more accurate true incidence.

After changing our institutional guidelines we have started to close Petersen's space and the meso-jejunal space at the time of the primary LRYGB. Since then, we have performed 239 PLRYGB (150cm Roux limb, 50 cm biliopancreatic limb) and 77 VVLL-LRYGB with primarily closed mesenteric defects using non-absorbable suture material. In total we had 43 reoperations in this group of patients and 2 IH's were detected at the time of reoperation. Inspection of mesenteric defects in this group showed persistent closure of Petersen's defect in 64.1% and meso-jejunal defect in 74.4%, respectively. This underlines the fact that even after closure of all defects partial reopening may occur in some patients, leaving the risk of IH. Due to the different LRYGB techniques in this group, the shorter follow up and a more experienced stage of the surgeon in respect to mesenteric defect closure, we did not perform a statistical comparison of groups. However, a reduction of the incidence of IH's between groups is clearly visible, therefore primarily closure of all mesenteric defects remains the standard of care at our institution.

All mesenteric spaces have the potential to form IH's. One possible explanation for the higher incidence of IH in the laparoscopic approach compared to open procedures (< 1%) [35;36] is less adhesion formation due to minimal intra-abdominal trauma compared to the open technique. This was supported by our intra-operative findings. Petersen's space spontaneously closed in 4.3% and meso-jejunal space in 13.8% of patients. Therefore, spontaneous adhesive closure of the defects cannot be expected per se. Some authors argue that omental splitting causes inflammatory reactions leading to adhesions at Petersen's space. Although being a standard step of our technique as well, we cannot support this hypothesis due to the low rate of spontaneous closure at the Petersen's space in our series. Despite being the most common performed bariatric

procedure at present, the technical steps of LRYGB are not yet standardized and variations between surgeons or centers are frequent. High variety exists in the type of gastro-jejunostomy (stapled or hand sewn), Roux limb and bilio-pancreatic limb lengths and the positioning of the Roux limb (ante-colic or retro-colic). An ante-colic Roux limb has several advantages [36-39]: the view on the gastro-jejunostomy back wall is better, the Roux limb can be well visualized during revisions and no additional defect through a mesocolic window has to be fashioned thus reducing the danger of meso-colonic bleeding or IH[39;40].

The closure of mesenteric defects is technically easy and does not substantially prolong the operation, but debate still exists. Rodriguez et al have shown a reduction in IH occurrence in Petersen's space with routine closure. They compared 187 patients with widely transected mesentery at the jejuno-jejunostomy, closure of the created defect but an open Petersen's space with a cohort of 172 patients without division of the mesentery but closure of the mesenteric folds and Petersen's space. The mean follow up was 15 vs. 12.3 months respectively. They reduced the incidence of IH's from 15% to 1% and concluded that patients benefit from careful closure of mesenteric defects[41]. Furthermore, a recently performed meta-analysis by Geubbels et al concluded that the antecolic technique with complete closure of the meso-jejunal and Petersen's space has the lowest incidence of IH following LRYGB[42]. Given these studies are the best current data they should serve as a basis for a standard technique.

Our experience with non-closure led to the modification of our surgical technique and closure of all potential defects with non-absorbable (Prolene® 3-0) interrupted sutures. Patients who present with abdominal pain after LRYGB with open mesenteric defects are planned for diagnostic laparoscopy. In case of open defects, closure is performed using non-absorbable interrupted suture. 31 patients were operated a third time, mostly because of pain. 11 of these patients demonstrated a mesenteric defect recurrence, and

one patient had IH. Absorbable suture material was used in five and non-absorbable in six of the patients with recurrent defects. Suter et al showed that using non-absorbable running sutures leads to a decreased incidence of IH[43]. However, even when non-absorbable material is used to close the defects, recurrence cannot be excluded, as shown in our data. In view of this, it is important to exclude IH even in patients with unclear pain who had previous closure, thus diagnostic laparoscopy is indicated as well. Closure of mesenteric defects does not exclude the patient from the risk of IH but it may reduce the need for reoperation.

Secondary closure of the defects can be performed safely laparoscopically but when IH is present the risk for conversion to open surgery is increased. Four of the five conversions occurred in patients with IH. Morbidity of the procedures was acceptable with one wound infection and three patients developing SBO due to tight closure of the defects and kinking at the entero-enterostomy, requiring re-operation. Attention not to cause kinking at the entero-enterostomy is mandatory. Kinking at the entero-enterostomy may cause dilatation of the biliopancreatic limb leading to a risk of bypassed stomach blowout therefore a floppy entero-enterostomy is important at the closure of the meso-jejunal defect. However, kinking might be higher during the learning curve of mesenteric defect closure.

Conclusion

The true incidence of IH might be underestimated due to the difficult diagnosis and the requirement for long-term surveillance. This paper analyzed primarily patients with non-closure of mesenteric defects and reoperation, thus representing a cohort where the incidence of IH was detected with 100% sensitivity. The spontaneous closure rate of mesenteric defects due to postoperative inflammation or adhesions is very low leaving a life-long risk for IH. Without closure of mesenteric defects the incidence of

IH is unacceptably high, and thus the closure of the mesenteric defects at time of primary LRYGB is recommended. IH may be present even in previously closed mesenteric defects regardless of the closure technique. Patients after LRYGB with or without closure of mesenteric defects with acute, chronic or intermittent pain should be referred urgently to a bariatric surgeon for diagnostic laparoscopy.

Disclosures

Dr. Delko has nothing to disclose.

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Table 1

Preoperative patient descriptives (n=146)

Male Female	21 125
Mean age (years)	43.8 ±10.4
Median time to reoperation (months)	41.1 (3-144)
Mean EWL prior to re-operation (%)	62.7 % ±20.6
Length of stay (days)	4 (1-76)

530 **Table 2**

531 Computed tomography (CT) scans in symptomatic patients
532

Total CT	48
Signs of IH	11
Cholecystitis	2
Gallstones	3
Urolithiasis	1
Umbilical hernia	1
No pathologic signs	30

533
534

Table 3

Intraoperative findings

Open Petersen's space	140
Open meso-jejunal space	126
Spontaneous closure Petersen's space	6
Spontaneous closure meso-jejunal space	20
Internal Hernia Petersen's Hernia Meso-jejunal Hernia	21 13 8
Adhesions	5
Umbilical hernia	2
Trocar hernia	4
Cholecystitis	3

538
539 **Table 4**

540 Computed tomography (CT) scans in patients with internal hernia
541

Total CT	14
Bowel wall thickening	5
Edema mesentery	3
Swirl sign	5
Bowel distension	4
Remnant stomach distension	4
No pathologic signs	3
No CT scan	7

542