



Laparoscopic subtotal gastrectomy in morbid obese patients: a valid option to laparoscopic gastric bypass in particular circumstances (prospective study)

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Abstract

Background Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) without resection of the distal stomach is largely performed over the world for morbid obesity. Potential risk of gastric remnant carcinoma development has been suggested.

Purpose To present the results obtained after LRYGB with resection of distal stomach.

Method This prospective study includes 400 consecutive patients. The mean body weight was 105.9 ± 16.8 Kg (range 83–145 kg), and body mass index (BMI) was 38.5 ± 4.4 kg/m² (32.9–50.3). Postoperative morbid–mortality and follow-up were analyzed.

Results Operative time was 128.5 ± 18.7 min, hospital discharge occurred at 3rd postoperative day, postoperative complications occurred in 9.25%, early surgical complications were observed in 3% and medical complications 4%, late surgical complications occurred 2.25%, no mortality was observed. At 1 year follow-up, BMI was 25.3 ± 2.7 kg/m² with % of weight loss (%WL) of $84.6 \pm 19.1\%$. At five years follow-up very similar values were observed.

Conclusion The results obtained after LRYGB with resection of distal stomach are similar to results published after non resection LRYGB regarding early and late results and can be indicated in high risk areas of gastric carcinoma.

Keywords Laparoscopy · Gastric Bypass · Gastric resection

Introduction

Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) without resection of the distal stomach is the procedure largely performed over the world for morbid obesity [1]. Some late postoperative complications related to the “in situ” gastric remnant have been published. The risk factors of gastric cancer developing after gastric bypass also have been suggested in spite the reported low rate of gastric carcinoma. Recently more and more cases have appeared in the literature, with very late diagnosis of advanced carcinoma associated with very poor prognosis, specially in some areas with high rate of gastric cancer [2–7].

Rarely several postoperative complications related to “in situ” gastric remnant have been published during the last two decades [8–12], that potentially are avoided if resection of distal stomach is performed.

In addition, high prevalence of histological pathologic lesions like intestinal metaplasia, lymphoid or atrophic gastritis, Gastro Intestinal Stromal Tumor (GIST) or dysplasia in the distal stomach in patients submitted to LRYGB has been described [8, 9].

Objective

In this prospective study, we present our early and late results performing gastric bypass with resection of the distal segment of stomach to demonstrate that this procedure does not increase postoperative morbid–mortality, presents similar results of non-resection gastric bypass, and therefore, could be indicated in areas with high risk areas of gastric cancer.

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Method

This prospective study includes the experience of the University Hospital of the University of Chile in a period of 10 years, from 2004 to 2014 in patients submitted to LRYGB with resection of distal stomach performed by the author (IB). The clinical data were stored in a specific database of our unit (Tycares® system) and the early and late postoperative complications, mortality and results of obesity indexes were analyzed. Four hundred consecutive patients were included in this study, 286 women (71.5%) and 114 men (28.5%) with a mean age of 34.4 ± 8.9 years. All patients had completed the preoperative multidisciplinary institutional protocol for evaluation of these patients. The mean body weight was 105.9 ± 16.8 Kg (range 83–145 kg), and Body mass index (BMI) was 38.5 ± 4.4 Kg/m² (range 32.9–50.3). One hundred six patients had BMI less the 35 and corresponded mainly to patients with esophagitis, Barrett's esophagus or diabetes type 2 and 1 patient with antrum Gastrointestinal Stromal Tumor (GIST), 176 patients had BMI between 35 and 39.9 kg/m² and 118 patients a BMI more than 40Kg/m², all of them with associated co-morbidities. Table 1 shows the associated co-morbidities diagnosed preoperatively. All patients gave their informed written consent for resection gastric bypass and this protocol was approved by the ethical committee of our institution.

Table 1 Associated co-morbidities observed in 400 obese patients who underwent resective gastric bypass

Associated co-morbidity	Patients (n [%])
Hyperinsulinism	83 (20.8%)
Dyslipidemia	60 (15%)
Arterial hypertension	58 (14.5%)
Type II diabetes	55 (13.8%)
Fatty liver	38 (9.5%)
Reflux disease without esophagitis	34 (8.5%)
Reflux with esophagitis	32 (8%)
Failed sleeve or adjustable band	29 (7.25%)
Long segment Barrett's esophagus	25 (6.3%) 7 with esophageal ulcer
Hypothyroidism	18 (4.5%)
Varicose veins	8 (2%)
Cholelithiasis	6 (1.5%)
Obstructive sleep apnea syndrome	5 (1.25%)
Hiatal hernia	5 (1.25%)
Obstructive sleep apnea syndrome	5 (1.25%)
Asthma	4 (1%)
Knee arthrosis	4 (1%)
Depression	2 (0.5%)
Infertility	1 (0.25%)

Surgical technique

The technique used was previously published in details (2). The gastroepiploic gastric branches are divided starting from 2 cm beyond the pylorus until the His's angle, and short gastric and posterior fundic vessels are divided. Division of the adhesions of the posterior antral wall to the anterior pancreatic face and exposing the posterior wall of the duodenal bulb is performed. The gastrohepatic ligament is opened at the avascular membrane and identification and division of the right gastric artery with Ligasure®, (Covidien, Mansfield, MA, USA) is performed. Division of the duodenum with Endogia stapler violet cartridge (Covidien, Mansfield, MA, USA) Division of lesser omentum 3 cm below the cardia. Then, a 45 mm Endogia device 4.8 mm stapler violet cartridge (Covidien, Mansfield, MA, USA) is introduced by the port located at the right quadrant to start the gastric division which is completed with 2–3 additional 60 mm violet cartridge stapler addressed up to the His's angle to perform the gastric pouch guided by gastric tube 36 French introduced by the anesthesiologist leaving a gastric pouch of 60 ml capacity. The great omentum is retracted to localize the Treitz's angle and identification of the biliary loop which is elevated to the gastric stump to perform gastrojejunostomy with 45 mm blue or white cartridge endogia. Reinforcement of the stapler line and closure of the orifice of the entrance of the instrument is done with Monocril® 000 sutures. (Ethicon, Cincinnati, USA). Afterwards, we performed latero-lateral jejunojunal anastomosis 170 cm distally with white cartridge 45 mm stapler Endogia (Covidien, Mansfield, MA, USA) in the same fashion. To exclude any leak of the suture line, we block transitorily the flux to the jejunum with a long intestinal forceps and the anesthesiologist instills 60 ml of methylene blue. Finally, we divided the biliary loop 2 cm from the gastrojejunostomy to complete the Roux-en-Y gastrojejunostomy. Figure 1 shows the distal segment of stomach removed and the final aspect of the procedure. To extract the specimen we only proceed to enlarge 2–3 cm the same right quadrant trocar orifice (3–4 cm for total incision length), which allow us to take out the gastric specimen without any difficulty. No infections were observed after this maneuver, because the specimen is completely closed.

A drain is placed close to the gastrojejunostomy and duodenal stump and exteriorized by the right quadrant port. We prefer to leave a small gastric stump and do not perform total gastrectomy because the rate of leaks after esophago-jejunoanastomosis occur most frequently and sometime is associated with other severe complications. On the contrary, the frequency of leaks after gastrojejunostomy is nil and not associated to major complications.

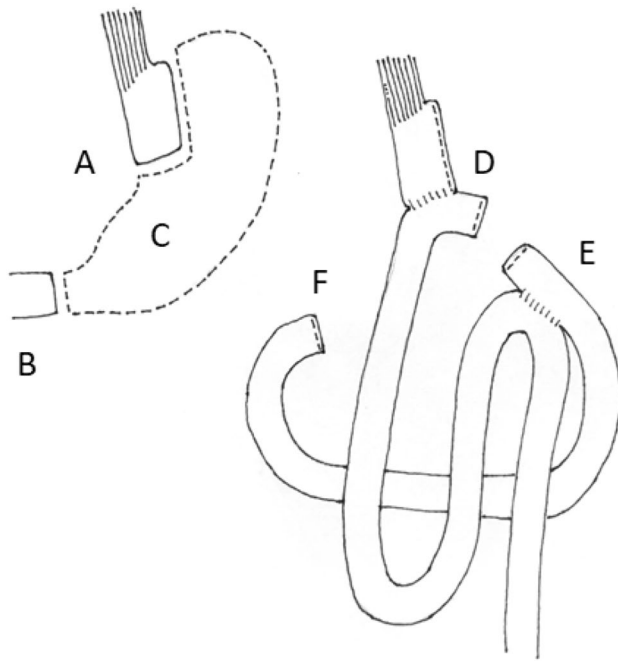


Fig. 1 Gastric bypass with resection of the distal stomach. **a** Line of gastric transection, **b** transection of duodenal bulb, **c** segment of resected stomach, **d** gastrojejunal anastomosis, **e** jejunum-jejunum anastomosis, **f** duodenal stump

Post-operative care

After the operation, patients were sent to a surgical intermediate care unit and stayed there for 1 day, being discharged to the regular room at 2nd postoperative day. During the 2 days, patients receive intravenous therapy and at third postoperative day patients were submitted to radiological evaluation with barium sulphate to evaluate the anatomy of the gastric pouch, to exclude leaks, anastomotic strictures or bowel obstruction. After this, oral liquid oral ingestion starts.

Follow-up

Patients were monthly followed-up during the first 6 months by surgeons and nutriologist to evaluate the body weight decrease, nutritional indications and vitamins supplement. After this, patients are controlled every 6 months.

In this paper, we report our results concerning operative time, early and late postoperative outcome, histological findings of the resected stomach, and follow-up, regarding the percentage of weight loss (%WL) and BMI decrease at least 3 years after operation.

For statistical analysis STATA 12 program was used.

Results

Associated co-morbidities were found in 43.4%. The main associated diseases were diabetes mellitus type II, fatty liver, and gastro esophageal reflux disease with or without esophagitis. Long segment Barrett's esophagus was also found in 6.25% of patients (7 of them with esophageal peptic ulcer). The other diseases less frequent are similar to previous publications. Helicobacter infection detected during the preoperative endoscopic was positive in 197 patients (49.3%) medical treatment was indicated. Conversion to LRYGB after failed sleeve gastrectomy or after adjustable gastric banding also were included (Table 1).

Operative time in this cohort was 128.5 ± 18.7 min. (The average operative time for non resectional gastric bypass performed by other surgeons in our hospital is 95 ± 10 min.) Hospital discharge in the majority of patients occurred at 3rd postoperative day, but the mean in-hospital stay was 4.8 ± 1.8 days, considering 37 patients who presented postoperative complications (9.25%).

Postoperative complications were classified as medical or surgical complications which are shown in Table 2. Surgical complications occurred in 21 patients (5.25%). Early surgical complications were observed in 12 patients (3%), 6 of them were re-operated, 3 patients at 2nd postoperative day (1 Hemoperitoneum due to trocar orifice bleeding, 1 small bowel injury, 1 early duodenal stump leaks), 2 small bowel obstruction at the jejunum-jejunum anastomosis reoperated at 4th postoperative day, 1 intraperitoneal abscess due to a small leak at the jejunum-jejunum anastomosis. Other 5 patients with peri-anastomotic collection were treated by percutaneous drainage and 1 patient with spleen injury which was treated with radiologic embolization. No mortality occurred in these patients. Late surgical complications occurred in 9 patients (2.25%), 7 of them re-operated due to internal intra-peritoneal hernias (Petersen's or Brolin's internal hernias) and 2 patients due to late duodenal stump leak which occurred 2 and 3 months after surgery probably secondary to intra-luminal duodenal hypertension due to partial stricture or torsion at jejunum-jejunum anastomosis.

Medical complications were observed in 16 patients (4%) in 2 patients due to porto-mesenteric thrombosis, 6 postoperative pneumonia and 4 patients with late gastric retention were treated with endoscopic dilatation and dietary indications, 4 upper gastrointestinal bleeding (anastomotic suture line) all of them resolved with medical conservative treatment without mortality. A summary of Clavien-Dindo's classification of the postoperative complications is shown in Table 3. The more frequent complications corresponded to II, IIIa or IIIb classification. Nobody from the patients needed ICU management and no mortality was observed in these 400 patients. (Type IV or V Clavien-Dindo's classification).

Table 2 Medical or surgical complications observed in 400 obese patients who underwent resective gastric bypass ($n = 37$)

Early surgical complications ($n = 12$)			
Hemoperitoneum	1	Re-operation (peritoneal lavage)	IIIb
Early duodenal stump leak	1	Re-operated (suture and drainage)IIIb	
Small bowel obstruction	2	Re-operated (jejuno-jejuno-re-anastomosis)	IIIb
Small bowel injury	1	Re-operate (jejunal suture)	IIIb
Intraoperative abscess	1	Re-operated (jejunal suture + peritoneal cleaning)	IIIb
Subphrenic collections	5	Percutaneous drainage IIIa	
Spleen injury	1	Spleen embolization	IIIa
Late surgical complications ($n = 9$)			
Late internal Hernias	7	Re-operated	IIIb
Late duodenal stump leaks	2	Re-operated (suture + drainage) (1 re-jejuno-jejunoanastomosis) (closure Petersen's and Brodin's space)	IIIb
Medical complications ($n = 16$)			
Porto-mesenteric thrombosis	2	Management classification ^a	
Anastomotic suture line bleeding	4	IV anti-coagulant treatment (Fragmin [®])	II
Postoperative pneumonia	6	Endoscopic hemostatic injection + PPIs	IIIa
Gastric retention	4	Antibiotics + kinesic therapy	II
		Endoscopic dilatation	IIIa

IV intravenous, PPIs proton pump inhibitors

^aClavien-Dindo classification

Table 3 The Clavien-Dindo classification of medical or surgical complications (summary) ($n = 37/400$; 9.25%)

Type I	0
Type II	8 (21.6%)
Type IIIa	14 (37.8%)
Type IIIb	15 (40.6%)
Type IV	0
Type V	0

Table 4 The histological findings of the mucosa of the resected stomach

Normal mucosa	91 (22.75%)
Abnormal mucosa	309 (77.25%)
Chronic gastritis	261 (65.25%)
Follicular	98 (24.5%)
Interstitial	93 (23.25%)
Lymphoid	38 (9.5%)
Atrophic	32 (8%)
Intestinal metaplasia	42 (10.5%)
Low-grade dysplasia	5 (1.25%)
GIST	1 (0.25%)

GIST gastrointestinal stromal tumor

Histological findings of the mucosa of resected stomach

The histologic analysis of the resected gastric stump was abnormal in 309 patients (77.25%) and normal mucosa as found in 91 patients (22.75%). The main pathologic finding was chronic gastritis (261 patients, 6.25%). Chronic atrophic gastritis and Intestinal metaplasia were found in 32 patients (8%) and 42 patients (10.5%) respectively, both recognized factors for gastric cancer development. GIST of distal stomach was found in 1 case with preoperative normal endoscopy. (Table 4) In spite of preoperative helicobacter eradication, presence of *Helicobacter pylori* was seen in 29 patients (7.2%).

Follow-up

During the first postoperative year all patients completed the follow-up by our multidisciplinary team. In spite to very close follow-up because the majority of these patients correspond to private patients, operated by only one surgeon, only 313 patients have been controlled at 3rd year and only 221 patients

have control at 5th year follow up. At 1 year follow-up, the mean BMI was 25.3 ± 2.7 kg/m² with % of weight loss (%WL) of 84.6 ± 19.1 %. At three and five years follow-up very similar values were observed. (Table 5).

All these patients remain under close control of a multi-disciplinary team including nutritional support with vitamins and mineral components to avoid anemia or other nutritional deficiencies. We have not observed more anemia or other deficiencies after resection. We have not observed differences concerning nutritional deficiencies among our patients with other patients without resection of distal stomach.

Table 5 The obesity index in terms of the preoperative and postoperative body weight, BMI and %WL observed during the follow-up in patients who received resective gastric bypass

	Preoperative	Postoperative Follow-up		
		1 year (<i>n</i> =400)	3 years (<i>n</i> =313)	5 years (<i>n</i> =221)
Weight (kg)	105 ± 16.8 (range 83–155)	70.2 ± 13.3 (range 51–87)	72.1 ± 15.4 (range 54–98)	77.7 ± 18.5 (range 55–102)
BMI (kg/m ²)	38.5 ± 4.4 (range 32.9–50.3)	25.3 ± 2.7 (range 23.1–30.5)	26.2 ± 3.7 (range 23.4–29.5)	29.8 ± 4.9 (range 24.9–33.8)
%WL	84.8 ± 19.1 (range 40.9–100.3)	71.5 ± 21.2 (range 31.2–100)	67.3 ± 23.3 (range 19.5–97.8)	

BMI body mass index, %WL percentage of weight loss

Discussion

We will discuss the reasons why it is possible to indicate resection of the distal remnant of stomach in patients with morbid obesity, taken into account the published data in the literature.

The first point to assume after this experience is that the addition of resection of the distal stomach during gastric bypass does not present increased morbid–mortality and the results obtained are quite similar to the published result observed in patients submitted to LGBP without resection of distal stomach [1, 2, 12].

Duodenal stump leakage do not happen after usual LRYGB because high pressure of duodenum leads to remnant gastric dilatation, therefore, no leakage is seen. This complication can occur after distal gastrectomy, however, in our experience it is nil (3 cases in 400 patients) and easy to treat it by early reoperation or with conservative treatment through a drainage left during surgery.

Obesity, pathological findings in gastric mucosa, *Helicobacter pylori* infection and family history of gastric cancer are factors involved in the appearance of gastric cancer.

Obesity is a factor associated with high risk of cancer due to a multiple patho-physiological mechanism involved in its pathogenesis, increasing two–threefold risk of gastric cancer. Bariatric surgery blocks these mechanisms, however, cases of gastric cancer after surgery can occur specially in high risk areas of gastric cancer. Therefore, we must prevent this situation [3–5].

Decreased risk of gastric cancer have been suggested for cardiac adenocarcinoma due to better control of acid and bile gastroesophageal reflux, but not for distal stomach [27–34].

Concerning cancer appearance after gastric bypass, there are 2 possible scenarios: the first one is cancer on the proximal stump and cardia which is related to missed pre-operative diagnosis, because the cases described were diagnosed very early (only few months after surgery) which mean that the tumor was not identified preoperatively and of course independent of the presence of distal gastric remnant.

The second one are tumors located in the distal stomach, which may happen after benign distal gastrectomy, which is 3–5 times more frequent compared to

general population, generally diagnosed very late, (range 1–29 years) associated with very poor prognosis [3, 12–17]. If we look at the publications concerning to the reported cases of gastric cancer after LRYGB it is possible to observe more and more cases not only in high risk areas and there are a vast list of publications about it [17–26]. Scozzari in a systematic review of literature, 28 articles describing 33 patients were retrieved. There were 11 esophageal and 22 gastric cancers; although adenocarcinoma represented most cases (90.6%), the mortality rate was 48.1% due to very advanced tumors, neoplasms were diagnosed at a mean of 8.5 years after bariatric surgery [27]. In Table 6 we summarize the available data regarding gastric cancer including cases exclusively in the gastric remnant after gastric bypass [5, 13, 16, 17, 19, 20, 22, 25–34]. In the same way, other authors conclude, that

Table 6 Cancer of the distal gastric remnant after gastric bypass: data from the literature

Author (ref)	Year	Cases (<i>n</i>)	Time after gastric bypass (years)
Raijarn [17]	1991	1	5
Lord [31]	1997	1	13
Khitin [19]	2003	1	22
Escalona [22]	2005	1	8
Babor [20]	2006	1	29
Corsini [25]	2006	1	4
De Roover [32]	2006	2	3 (Lymphoma)
12 (malignant GIST)			
Harper [13]	2007	1	1
Watkins [28]	2007	1	18
Swain [5]	2010	2	20
			21
Wu [16]	2013	1	9
Menendez [26]	2013	1	3
Nau [33]	2014	1	2
Tinoco [24]	2015	1	10
Magge [34]	2015	2	28
			25
Haenen [29]	2016	1	7

up to date, it is not possible to quantify the incidence of esophagogastric cancer after bariatric surgery because of the paucity of reported data. Nevertheless, because the main concern is the delay in diagnosis, it is of critical importance to carefully evaluate any new or modified upper digestive tract symptom occurring during bariatric surgery follow-up which will be very close with CT scan annually in high risk areas because the impossibility to perform periodic upper endoscopy [3, 13, 27–34].

Gastric cancer incidence rates vary across different countries, the highest incidence rates are observed in East Asia, East Europe and South America. Chile is one of the countries suffering with a high incidence of gastric cancer. The current mortality rate for gastric cancer in Chile is 25,4/100.000 inhabitants and is included among the countries catalogued as high risk area according to the age standardized incidence rate, ASIR > 20/100.000 inhabitants after Japan, Korea and China, countries that concentrated the 60% of Gastric Cancer in the world. Other Latin-American countries with high rate of gastric cancer are Colombia and Costa Rica [35, 36]. These countries have a big population with morbid obesity, candidates for bariatric surgery.

In our hospital, a patient submitted to non resectional gastric bypass operated on by other team 3 years before, presented advance gastric cancer and died due to peritoneal carcinomatosis. Other 2 patients were detected to have early gastric cancer during preoperative upper endoscopy, they were submitted to total D2 gastrectomy.

Concerning to the pathophysiologic mechanisms probably involved in the genesis of gastric cancer after gastric bypass there are presence of chronic bile reflux, antral intestinal metaplasia (12–19%), presence of helicobacter infection, bacterial overgrowth and carcinogens all these factors could promote the development of gastric cancer in this segment which is difficult to detect until the tumor has advanced disease. Kuga and others have found bile in gastric stump in 68% of patients submitted to gastric bypass very similar to the result published by Brazilian's and Swedish's authors [6, 7, 30, 35, 36]. Increased fungal and bacterial presence promoting chronic gastritis and presence of secondary biliary acid, which are recognized as carcinogenetic over gastric mucosa [35–38]. Another reason is the presence of histopathological lesions found in distal stomach [6, 7, 12, 33]. Presence of gastric pathological lesions ranges from 32 to 74%. Chronic atrophic gastritis and intestinal metaplasia range from 6.5 to 19% and *H. pylori* (+) in a high proportion of cases are conditions for gastric cancer development. *Helicobacter pylori* presence seems to be a risk factor for gastric cancer, even after Roux-en-y gastric bypass [30, 39]. In Chile, the prevalence of *Helicobacter pylori* fluctuates from 60 to 78% depending to the area (rural or not).

The mechanisms described for developing stump gastric carcinoma after surgery for benign lesions (Billroth I or II

operation) could be the same for distal remnant stomach cancer after gastric bypass.

The other factor mentioned is the familial aggregation and a positive family history (having a first degree relative with gastric cancer) is a risk factor for gastric cancer. The magnitude of the relative risk differs by country and study, ranging from 2 to 10. Hereditary diffuse gastric cancer, familial adenomatous polyposis and Peutz–Jeghers syndrome must have attention in obese patients candidate to bariatric surgery [30].

Therefore, we can think whether it is possible to do cancer prevention after gastric bypass, the answer is YES exclusively for cardia and distal esophagus carcinoma because we can avoid acid and bile Reflux to upper stomach and distal esophagus, prevent Barrett's esophagus and adenocarcinoma appearance. However, distal Gastric Cancer developed in high risk areas associated with the mentioned pathophysiological mechanisms and in presence of other risk factor above mentioned can be frequent as have been suggested by Japanese and Korean authors [1, 4, 16, 30].

Therefore, in countries with high rate of gastric cancer it is valid to postulate bariatric surgery with resection of the distal stomach. Asian's authors have suggested to perform surgical procedures for morbid obesity, which involve resection of the stomach [16]. Therefore, Kasama propose to perform sleeve gastrectomy plus duodeno-jejunal bypass for morbid obese patients in Asia and Madan suggested, when a suspicious distal gastric lesion is present preoperatively, a distal subtotal gastrectomy may be needed. LGBP with subtotal gastrectomy for morbid obesity should be considered for patients with suspicious distal gastric lesions [35, 36].

This study concludes that resection gastric bypass is technically feasible and may be a viable option in countries with a high risk of gastric cancer and with well-trained surgeons in this technique. Resection gastric bypass has been shown to be as effective in 5-year weight loss as the non-resection technique, without increasing postoperative morbidity and mortality. Patients present a significant decrease in excess weight. In the second place, the technical aspect is favored by the space that gives the gastric resection to perform the anastomosis, although the resection technique presents a slightly greater time to the classical technique (15–20 min more on average). Several complications have been associated with the non-resection technique, such as erosive gastritis or peptic ulcer hemorrhage, gastro-gastric fistulas, perforated gastric ulcers and anastomotic ulcer, which have not been found in the resection technique [2, 12]. The most fearsome postoperative complication after gastric resection is the duodenal stump leak, however, in the present experience only 2 patients presented this complication.

In this study, we have confirmed very similar results to the previous publication in 2011(2), but now including four hundred consecutive patients. The limitation of this study is

because the showed results correspond to the experience of a single surgeon.

Conclusions

Therefore, due to all the considerations taken into account, resection of distal remnant is valid in:

- High risk areas: Asia, Latin-America, Eastern Europe and some areas of Western Europe (Central Italy)
- Preoperative Endoscopic and Histologic abnormalities, mainly atrophic gastritis and intestinal metaplasia
- Familiar History of gastric cancer
- Bile reflux and bacterial overgrowth—promotes carcinogenesis

In addition, non-resection gastric bypass is not exempt of in situ gastric remnant complications, which are avoided when performing resection of the distal stomach and in Chile we suggest to perform always this procedure.

Compliance with ethical standards

Conflict of interest All authors declare they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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