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ORIGINAL CONTRIBUTIONS

Manometry of the Upper Gut Following Roux-en-Y Gastric Bypass Indicates That the Gastric Pouch and Roux Limb Act as a Common Cavity

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Abstract
Background The motility of the upper gut after Roux-en-Y gastric bypass (RYGBP) is underexplored. We aimed to investigate the oesophago-gastro-Roux limb motor activity during fasting and after food intake.
Methods Eighteen morbidly obese patients were examined at least 2 years after RYGBP. A high-resolution manometry catheter was positioned to straddle the oesophagogastric junction, the gastric pouch and the proximal Roux limb using transmucosal potential difference measurements. Three patients with vertical banded gastroplasty (VBG) were also studied.
Results During the fasting state, the gastric pouch had low or no activity whereas the Roux limb exhibited regular migrating motility complexes (MMCs) being initiated just distal to gastroenteroanastomosis. Median cycle duration was 72 min, and the median propagating velocity of the phase III MMC phase was 2.7 cm/min ($n=8$). When patients were asked to eat until they felt comfortably full, intraluminal pressure increased by 6 to 8 cmH_2O without any significant difference between gastric pouch and the Roux limb ($n=9$). The increased intraluminal pressure following food intake correlated neither to weight loss nor to meal size or rate of eating.
Conclusions A successful RYGBP is associated with MMC in the Roux limb during fasting. The gastric pouch and the Roux limb behaved as a common cavity during food ingestion. Data do not support the hypothesis that the alimentary limb pressure in response to food intake influences either meal size or weight loss.

Keywords Motility · Stomach · Intestinal · Bariatric · Intraluminal pressure

Introduction

The World Health Organization states that obesity has nearly doubled worldwide since 1980 [1]. Surgical interventions, such as the gastric bypass technique, are associated with pronounced weight reduction and reduced co-morbidity over the long term [2]. The surgical procedures were originally designed to either restrict food intake by mechanical means (e.g. via band-narrowing of the gastric lumen) or induce calorie malabsorption (by reducing intestinal mucosal surface available for absorption). The Roux-en-Y gastric bypass (RYGBP) was thought to combine restriction and malabsorption, but today, altered physiology such as satiety gut hormones, increased meal-induced thermogenesis and altered gut microbiota are explored as mechanisms of RYGBP and other bariatric procedures [3]. Gastric emptying rate and transit time to the distal small intestine may also influence food intake [4]. We have previously demonstrated that the Roux limb may have a role in regulating food intake after RYGBP, as the thresholds for eliciting distension-induced sensations in the proximal Roux limb and intraluminal pressure during distension were negatively correlated to meal size [5]. However, the Roux limb volume–pressure relationship following balloon or food distension is dependent on the wall muscular tone. With exception of a few studies concerning oesophageal reflux, very little is known about the muscular activity of the oesophagogastro-

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Roux segment [6]. The motility of the Roux limb after total and subtotal gastrectomy for gastric cancer or ulcer disease has been studied using manometry in relation to the Roux stasis syndrome [7–11]. However, manometry of upper gut motility after RYGBP has not previously been reported. The aim of the present study, therefore, was to investigate the oesophago-gastro-Roux motor activity during fasting and during food intake in weight-stable patients at least 2 years after uncomplicated laparoscopic RYGBP. Three cases of vertical banded gastroplasty (VBG) were included for comparison.

Material and Methods

Study Subjects and Ethical Statement

Patients that had previously undergone uncomplicated surgery with an antecolic–antegastric RYGBP (as described in detail elsewhere) [12, 13] were recruited. Table 1 shows the patient demographics. Exclusion criteria included the following: revisional surgery, severe co-morbidity except adequately controlled type 2 diabetes mellitus and hypertension. The time after primary surgery was at least 2 years to ensure stable weight and health. Two study protocols were used: the first to assess patients while fasting and the second after food intake (see below). One subject participated in both these investigational sets. A third protocol was used for patients who previously had a vertical banded gastroplasty (VBG). All procedures performed 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. The study protocol was approved by the Regional Ethical Review Board in Gothenburg (Dnr: S 674-03). Informed consent was obtained from all individual participants included in the study.

Investigational Procedures

The examination was performed in the morning after an overnight fast. The subject rested in a comfortable semi-recumbent position. A multi-lumen silastic catheter (a customized Ch12 gastrointestinal manometric catheter, CE4-1024, Dentsleeve International LTD, Mississauga, Ontario, Canada) was inserted nasogastrically. The catheter included 22 separate channels with corresponding side holes positioned 10 mm apart, thus covering 21-cm length. The catheter was fixed at one nostril and so positioned that it straddled the oesophagogastric junction, leaving three to five side holes in the distal oesophagus including the lower oesophageal sphincter (LES) and the rest in the gastric pouch and the proximal Roux limb (Fig. 1). Each side hole was connected to a pressure transducer that was separately fed with a low flow of 150 mmol/L NaCl (3 mL/h). Pressure measurements via fluid-perfused catheters with externally placed transducers are sensitive to body movements; thus, the study subjects were asked to remain in the same position as much as possible. A correction factor compensated for the increased hydrostatic pressure along the manometric catheter secondary to the fixed semi-recumbent body position.

The position of the catheter was confirmed by fluoroscopy and 'manometric landmarks', i.e. the high-pressure zone (HPZ) indicating LES and the pressure inversion point (PIP) following forced inspiration, thus distinctly indicating the border between the thorax (negative pressure) and the abdomen (positive pressure) and vice versa at expiration. In protocol 1 (see below), each pressure recording line (thus electrically isolated from each other) was also used as an electrode for electrical potential recording via an Ag–AgCl bridge that was connected to a high-impedance voltmeter, with a reference electrode positioned subcutaneously. Thus, in these experiments, both the intraluminal hydrostatic pressure and transmucosal electrical potential difference (PD) at each side hole were displayed online and stored for later analysis on a Macintosh personal computer (Apple Computers, Cupertino, CA) by use of specially designed software (LabVIEW; National instruments, Austin, TX). The side hole recordings were plotted as a function of the distance from the nostril, allowing simultaneous identification of (1) the pressure profile along the distal oesophagus and oesophagogastric junction and (2) the transmucosal PD. The latter was used as an online functional index of the anatomical site for each pressure recording. Transmucosal PD during baseline fasting conditions is generally lumen-negative with typical value in the oesophagus of 10–15 mV, in the gastric lumen of 20–50 mV and in the small intestine of 1–5 mV [14, 15].

Table 1 Study participants

	Number (females)	Age in years; median (range)	Months, after surgery; median (range)	%TBWL median (range)	Persisting co-morbidity
Protocol 1: RYGBP, fasting	9 (5)	48 (28 to 60)	33 (28 to 46)	31 (17 to 39)	None
Protocol 2: RYGBP, meal test	10 (2)	51 (39 to 62)	31 (28 to 53)	29.5 (12 to 39)	None
Protocol 3: VBG, meal test	3 (2)	45 (41 to 48)	>48	24 (20 to 33)	None

%TBWL total body weight loss in percent

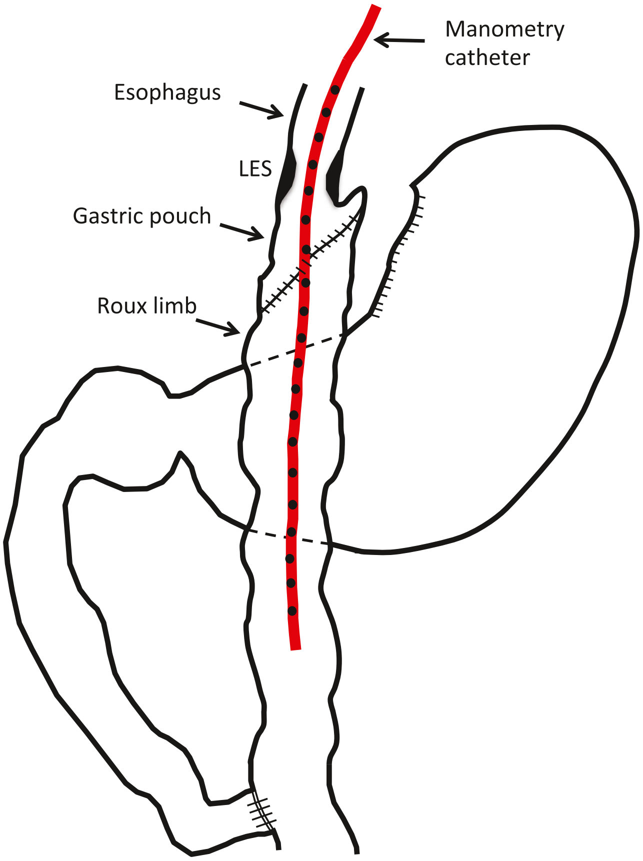

Fig. 1 Position of the side hole manometry catheter. Note that the anatomical proportions are erroneous

An Anatomical Consideration

The manometric catheter was positioned to cover the distal oesophagus with LES, the gastric pouch with the gastroenteroanastomosis and the proximal Roux limb. It should be noted that with our laparoscopic surgical technique, the jejunum is connected to the posterior wall of the gastric remnant by a 45-mm linear staple. The gastric pouch is approximately 40–50 mm long, but the anastomosis is obliquely oriented in relation to the cranial–caudal axis. The aboral part of the posterior wall of the pouch consists of jejunum whereas the anterior wall is derived from the stomach in an overlapping manner (Fig. 1).

Experimental Protocols

Protocol 1: Fasting Motility (n= 9)

After catheter placement, spontaneous pressure activity in the oesophagogastro-Roux segment was recorded over 2 to 3 h (median 180 min; range 128 to 229 min). The manometric profile was characterized in relation to anatomical and functional landmarks. The different phases of the interdigestive migrating motility complexes (MMCs) in the Roux limb include the following: *phase I* was defined as motor quiescence with two contractions per 10 min or less occurring after a phase III period, *phase II* was a period with contractions of a frequency of between 2 and 8 per minute and with irregular propagation (i.e. not fulfilling the properties of either phase I or III), and *phase III* was a distinct and >2-min-long period of coordinated powerful contractions at a frequency between 10 and 12 per min, propagating in the aboral direction [16].

Protocol 2: Food Intake After RYGBP (n= 10)

After catheter placement, we waited for the completion of a phase III MMC in the Roux limb. All study participants exhibited phase III activity within 90 min. Fifteen minutes after that the MMC high-activity complex had passed, the study subject was served a mixed meal consisting of 300 g of Swedish Hash, i.e. a mixture of meat, potatoes and onions with 150 kcal/100 g, 16 energy% protein, 42 energy% carbohydrates and 42 energy% fat. The subjects were instructed to eat until they felt comfortably full. Time from start to end of ingestion was measured, as well as the weight of remaining food. The subjects did not drink *during* ingestion. One glass of water was allowed after the meal to rinse their throat. The manometric recordings were maintained after meal ingestion to a median total recording time of 163 min (range 130 to 213 min).

Protocol 3: Food Intake After VBG (n= 3)

Three subjects that had undergone VBG were examined according to protocol 2. The median recording time was 142 min (range 95–145 min)

Statistics

The data sets were tested for normal distribution using the Shapiro–Wilk test. As Gaussian distributions could not be ascertained, non-parametric methods were used. The data sets are in text, figures and tables given as median and range, except in Figs. 5 and 6 where group means are used for the sake of graphical clarity. The Kruskal–Wallis test and Spearman correlation were used in the analyses of meal-associated data. All statistical analyses were performed using Prism 6 GraphPad Software Inc.

Results

Baseline Pressure Along the Oesophago-Gastro-Roux Segment

The oesophago-gastro-Roux pressure profile was calculated in each individual as the mean of three different 5-min recordings during baseline without significant motor activity (thus excluding, for example, oesophageal primary peristalsis and Roux limb phase III motor activity). Regarding the subject that participated in both the investigational protocols, we only used data from protocol 1 in this analysis. By assessing the PIP, we were able to identify the border between the thorax and the abdomen. The high-pressure zone (HPZ) indicating the position of LES were in all cases at, or immediately below, the PIP. When adjusted to the highest individual pressure value in the HPZ, a pressure profile appeared as shown in Fig. 2. As expected, transmucosal PDs indicating gastric mucosa (i.e. >20 mV) were usually observed 1 to 3 cm immediately distal to the HPZ. However, as can be seen in Fig. 2, there were cases that exhibited PD>20 mV also at the level of the peak pressure indicating an extension of gastric mucosa into the LES. A pronounced PD variability was observed 3 to 4 cm distal to the peak pressure probably reflecting the gastroenteroanastomosis (GEA) with overlapping gastric (high transmucosal PD) and small intestinal mucosae (low transmucosal PD) as depicted in Fig. 1. The baseline pressure difference between the HPZ (max) and the distal gastric pouch/GEA area was 36 cmH_2O (median; range 12 to 67). Interestingly, there was no difference in pressure between the GEA and the Roux limb, suggesting that there was no flow restriction at the GEA (Fig. 2).

Motor Activity in Fasting

The fasting period was characterized by primary peristaltic (swallow induced) oesophageal pressure waves with preceding LES relaxation (abolished HPZ) (Fig. 3). Most subjects also exhibited occasional transient lower oesophageal sphincter relaxations (TLESRs; a 10- to 25-s sphincter relaxation without preceding oesophageal peristalsis and associated with a powerful subsequent sphincter contraction lasting usually 10–30 s; not shown in figure). The pressure in the gastric pouch area remained low also when a typical MMC pattern was apparent in the Roux limb (Fig. 3). One to four (median 3) phase III complexes appeared in the study group during the observation period. All phase III complexes started in the most proximal part of the Roux limb and propagated aborally, thus not involving the gastric pouch (example shown in Figs. 3 and 4(A)). Roux limb MMC cycle duration was calculated as time from end of two consecutive phase III complexes (thus excluding the subject only exhibiting one phase III complex during the study period). Median cycle duration was 72 min (range 62 to 133; $n=8$), and the propagating velocity of phase III was 2.7 cm/min (range 2.0 to 3.9; $n=8$).

The frequency characteristics of the different MMC phases were analyzed using one pressure channel in

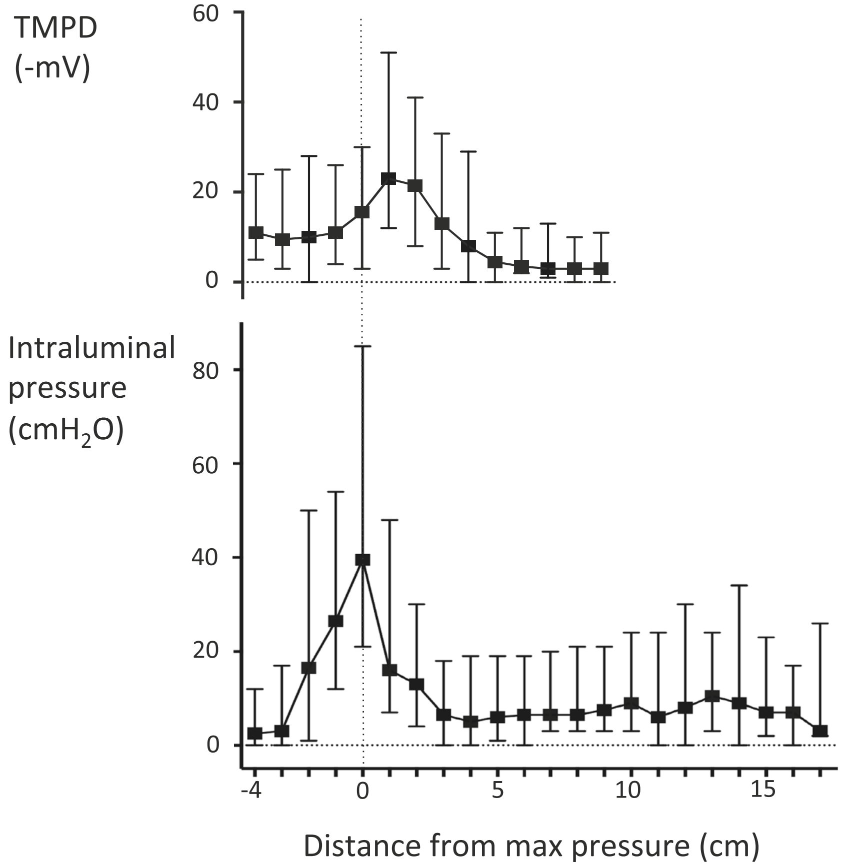

Fig. 2 Intraluminal pressure and transmucosal potential difference (PD) along the manometry catheter during *baseline* conditions in 12 RYGBP patients. The values are related to the highest pressure recorded in the high-pressure zone (HPZ) of the oesophagogastric junction in each individual (0 on the *x*-axis). Note that transmucosal PD values typical of oesophageal mucosa (<15 mV) and of gastric mucosa (>20 mV) were recorded immediately before and after the HPZ (*nb* all PD values being lumen-negative). Data are plotted as median and range, $n=12$

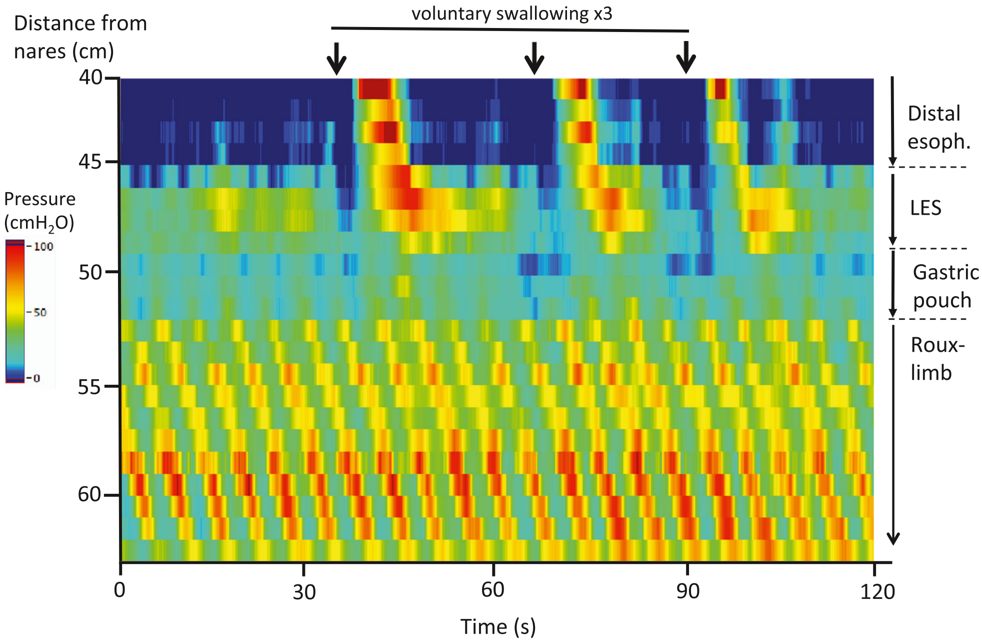

Fig. 3 Two-minute recording (*x*-axis) with high-resolution manometry of the oesophagogastro-Roux area (*y*-axis; corresponding anatomy is given to the *right*) in one female RYGBP patient. Pressure is encoded in *colour* (see range at *left*). Note the ongoing MMC phase III motility in the Roux limb being apparently independent of the oesophageal primary peristalsis induced by the three voluntary dry swallows (*arrows at the top*)

the proximal Roux limb 2 to 3 cm distal of the starting point of phase III. The migrating high-activity complex (phase III) exhibited a contraction frequency with a median of 12 pressure waves per minute (range 11–14 pressure waves per minute). The motor activity during 15 min before the high-activity complex (per definition: late phase II) was characterized by irregular contractions with a median frequency of three pressure waves per minute. Phase I motor activity was assessed during the 15-min period immediately after each high-activity complex (i.e. phase III) and was, in all subjects, characterized by motility quiescence with no contractions.

Effect of Food Intake

Instrumented with the nasogastro-Roux tube, the RYGBP patients were instructed to eat until feeling comfortably full. Data on meal duration, meal size and the eating rate are shown in Table 2. The food intake resulted in propulsive contractions in the Roux limb and a moderate pressure increase of the gastric pouch area only slightly exceeding the Roux limb pressure (example given in Fig. 4(B)). In order to allow group analysis of pressure development over time, the pressure profile along the recording catheter was related to the highest recorded value in the HPZ of LES of each individual prior

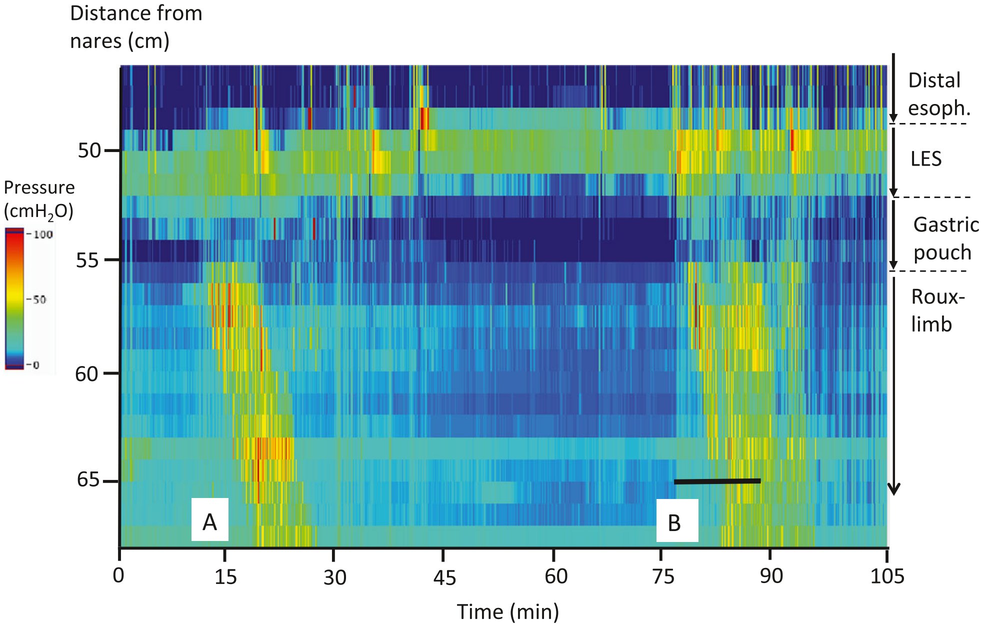

Fig. 4 High-resolution manometry of the oesophagogastro-Roux area (with distance from nares on the left *y*-axis and corresponding anatomy at the *right*) in one RYGBP patient. Intraluminal pressure is encoded in *colour* (see range at *left*). Note the appearance of a MMC phase III-like motility complex starting in the Roux limb some 15 min after onset of recording (*A*). At time 75 min, the patient ingests food until satiated (13 min, marked with a *bar* at *B*). Note the moderate pressure increase in the gastric pouch during and after food intake speaking against outlet obstruction at the gastroenteroanastomosis

Table 2 Meal-related data and the associated regional manometric findings in RYGBP patients

Meal duration (min)	14 (8 to 18)	
Meal size (g)	162 (93 to 300)	
Eating rate (g/min)	12 (9 to 24)	
	Pressure net change (cmH_2O)	Pressure progression (cmH_2O per min)
Pouch	6 (0 to 14)	0.4 (0 to 1.8)
Prox Roux	8.5 (0 to 25)	0.5 (0 to 2)
Roux+10 cm	7.5 (0 to 14)	0.3 (0 to 1.8)

Data are given as median (range), $n=10$. Pressure net changes were between baseline before food intake and to when the individual had stopped eating

to food ingestion (the baseline condition). Boluses of chewed and swallowed food caused rapid deflections from the baseline profile reflecting the propulsive activity. By integrating the pressure data into 2-min intervals, the food intake caused a moderate and gradual pressure increase in the gastric pouch as well as in the Roux segment. In most subjects, the gastro-Roux pressure was highest after 8 min and tended then to decrease despite continued food ingestion (Fig. 5).

The Gastro-Roux Segment Behaved as a Common Cavity upon Food Reception

A comparison of the manometric values recorded (1) at the level of the gastric pouch, (2) at the level first 2 cm of the Roux limb and (3) 10 cm distally (one recording point at each level) was performed during food intake (Table 2). The pressure change (delta cmH_2O) from baseline (immediately before ingestion) to when the individual stopped eating, as well as the pressure progression (pressure change per time) during the ingestion period in the gastric pouch area, did not differ from values recorded in the first or more distal parts of the Roux segment under study (the Kruskal–Wallis test).

No Correlation Between Intraluminal Pressure and the Meal Intake Variables and Weight Loss

The meal-associated intraluminal pressure changes (as defined above) correlated neither with meal size or meal duration nor with the percentage total body weight loss (%TBWL).

The Oesophageal Pressure Increased During Meal Intake in VBG Patients

The pressure profile of the oesophagogastric segment in the VBG patients ($n=3$) differed markedly from that in the RYGBP patients. Food intake in the VBG patients built up a marked and sustained pressure proximal to the estimated position of the band and also in the distal oesophagus (Fig. 6).

Discussion

We previously proposed that biomechanical properties of the Roux limb wall could contribute to the determination of meal size after RYGBP. In that study, we assessed the intraluminal volume–pressure relationship following balloon distension [5]. The present study focussed on the intraluminal pressure of the gastric pouch and the proximal part of the Roux limb in response to food intake. We did not obtain, however, data supporting a relationship between intraluminal pressure and meal size. The present investigation also demonstrated a fasting motility pattern with MMCs occurring in the Roux limb.

It should be noted that the investigated part of the RYGBP has principally two functional states, the *interdigestive* fasting state and the activity during food intake, the *ingestive* state. Due to a rapid emptying rate of the small-sized gastric pouch, the *postprandial digestion/absorption* phase of the Roux limb is very short and of more relevance for the more distally situated part of the intestine that, for technical reasons, was not included in the present study. The present set-up also allowed a high-resolution manometric analysis of the distal part of the oesophageal body and the LES area. Of interest was that the oesophago-gastric junction was situated at, or immediately below, the functional border between the thorax and abdomen as indicated by the PIP during breathing, indicating that there was no hiatal herniation in the patients.

Furthermore, the manometric features of the LES were within normal range both regarding sphincter endurance and the primary peristalsis-associated LES relaxations [17]. Typical TLESRs occurred with expected duration and frequency [18]. Gastric pouch motility was generally low during fasting conditions in all patients, whereas a cyclic motility pattern typical of MMC was present in the Roux limb. The MMC is a motility pattern occurring in the interdigestive state and has three major phases of which phase III is the most prominent and is constituted of a cluster of powerful propagated contractions migrating from the stomach or duodenum towards the distal small intestine [16, 19]. In addition to gastrointestinal wall mechanical activity, several

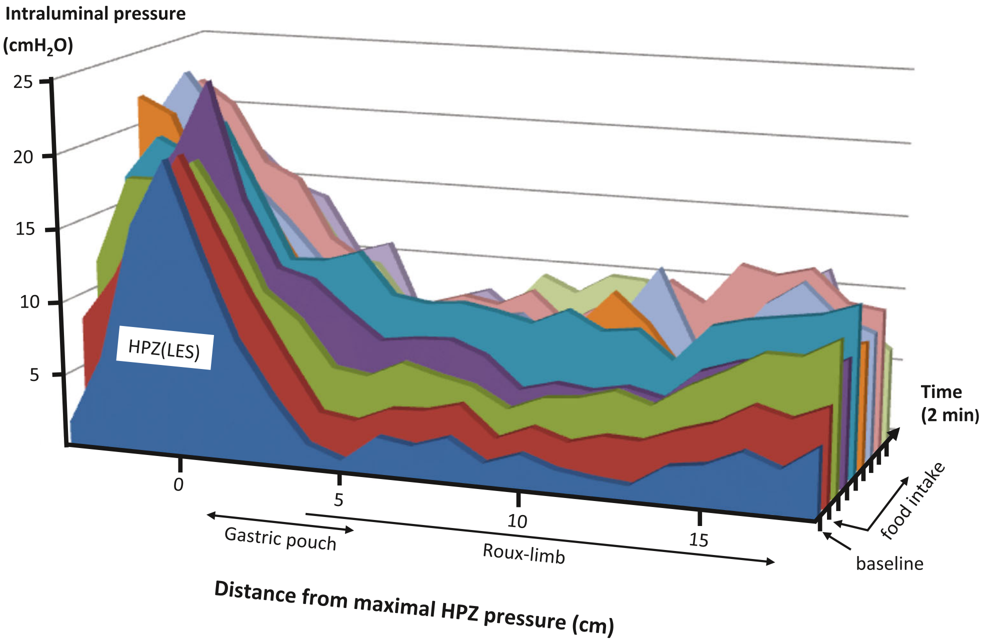

Fig. 5 Mean intraluminal pressure (*y*-axis) in 2-min periods (*z*-axis) in ten patients with RYGBP before (baseline) and during voluntary food intake. Pressure is plotted along the oesophago-gastro-Roux catheter in relation to the highest pressure recorded in the high-pressure zone (*HPZ*) at the level of the lower oesophageal sphincter (*LES*) during baseline conditions. Estimated anatomical landmarks are indicated. Note the general upward transposition of the gastro-Roux pressure curve during food intake. The indication of food intake along the *z*-axis is the 10-min period when most subjects were eating. The time to termination of meal varied and is not indicated

secretory processes are simultaneously and shortly activated, for example, gastric acid, bile and pancreatic secretions, all being integrated by the enteric nervous system into a complete secretomotor programme [20]. The function of this propagating muscular activation is probably to clear GI lumen from secretions and cellular debris during the fasting state [20]. The presence of MMC in the Roux limb has previously been reported in patients subjected to gastric resections but is, to our knowledge, never before described following RYGBP for weight-reducing purposes. The pacemaker of most MMCs is proposed to be located to the mid-distal stomach. Gastric phase III contraction has a low frequency, usually of two to four contractions per minute. These gastric contractions can be propagated via the pyloric junction into the duodenum, and there be continued as duodenal phase III activity complex, then usually with a frequency of 11–13 contractions per minute and with a duration of at least 2 min. Approximately 70 % of the small intestinal activity fronts originate in the stomach, but some 30 % start in the proximal duodenum [21]. The MMC pattern is coordinated by a network of so-called Cajal cells in the gut wall with close association to the enteric nerves. Phase III has been

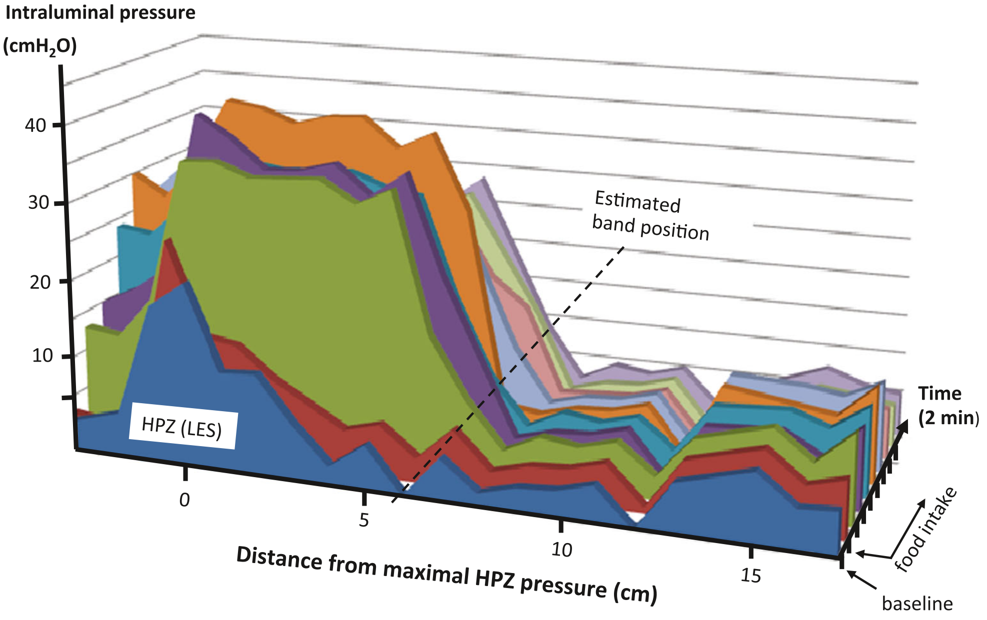

Fig. 6 Mean intraluminal pressure in 2-min periods (*z*-axis) in *three* VBG patients before (baseline) and during voluntary food intake. Pressure is plotted along the oesophago-gastric catheter in relation to the highest value recorded in the high-pressure zone (*HPZ*) at the level of the lower oesophageal sphincter (*LES*) during baseline conditions. Estimated position of the gastric band is indicated. Note that the pressure increases proximal to the estimated position of the gastric band and also that the oesophageal pressure increases (i.e. proximal to HPZ) upon food intake

associated to liberation of several endocrine mediators, and particularly, motilin and ghrelin have gained considerable interest. When given exogenously, both these mediators exert prokinetic properties, but exact physiological roles are still to be established [22]. Gastric phase III-like contractions were long ago proposed to be associated with hunger sensations [23]. However, the link between fasting gastric motility and hunger needs more investigation [24]. In the present study, only the proximal gastric pouch was accessible for manometry. This small part of the proximal stomach did not exhibit any MMC pattern probably reflecting the disconnection from the rest of the organ and, therefore, a lack of stimulatory input. An additional explanation is that manometry may fail to mirror motility of large dimensioned hollow organ. An empty gastric pouch may thus be unable to produce an increased intraluminal pressure during wall contractions, whereas after food intake, the luminal contents will better transmit potential pressure oscillations. The present measurement shows that phase III of the MMC is activated and propagated from the most proximal part of the Roux limb. Le Blanc-Louvry et al. have previously shown that the propagation velocity of phase III is markedly slower in the Roux limb after gastrectomy compared to the same (jejunal) segment before surgery, as well as when compared to jejunal MMC in healthy volunteers [25]. The Roux limb phase III manometric characteristics of the present uncomplicated RYGBP patients were thus very similar to those described for the Roux-en-Y limb of asymptomatic patients after gastrectomy.

The size and degree of food-induced distension of the gastric pouch have previously been proposed to determine food intake and long-term weight loss [26–29]. In the present study, the three VBG patients were included to illustrate the patterns when passage of food is restricted. Indeed, food intake in these patients resulted in increased intraluminal pressure, not only proximal to the band but propagated also into the distal oesophagus. The difference between the VBG and RYGBP patients was striking. Pouch hypertension during the ingestive phase indicating an outlet flow restriction was never observed after RYGBP. Instead, the intraluminal pressure increased similarly along the gastro-Roux axis during food ingestion. The increased pressure lasted until termination of food intake after which intraluminal pressures returned towards pre-meal values over the next 5 to 6 min. Apparently, the pouch and the proximal Roux limb acted as a common cavity during the ingestion in the RYGBP patients.

The absence of pouch distension upon food intake is perhaps not surprising considering the wide gastrojejunal anastomosis used [12, 13]. Thus, there was no flow resistance at the GEA in the presently investigated patients. Furthermore, neither the net increase in the Roux limb intraluminal pressure, nor the rate at which the pressure increased, correlated with either meal size or ingestion rate. Also, total weight loss lacked significant correlation to the meal-induced Roux limb pressurization. Thus, these findings do not support that Roux limb wall mechanics contribute to weight loss as previously proposed [5]. However, the investigational conditions, particularly the presence of a nasointestinal tube, might have influenced the ingestive behaviour of the study participants. Speaking in favour of such an influence are data from other studies in our laboratory showing larger preferred meal size and eating rate in subjects without nasointestinal intubation [5, 30]. Another obvious limitation of the present study was the relatively low number of subjects. On the other hand, the oesophagogastro-Roux limb manometric patterns of these post bariatric surgery patients showed a low interindividual variability suggesting an acceptable homogeneity in the study population. Dumping or postprandial nausea, vomiting, abdominal pain and other gastrointestinal symptoms are not uncommon after gastrectomy with Roux-en-Y reconstruction, and such symptoms have been associated with dysmotility manifested, for example, as the Roux limb stasis syndrome [7, 31]. Similar gastrointestinal symptoms may occur also after RYGBP, and it must be emphasized that the patients investigated in the present study were included because they were *without* any such symptomatology. The present results can, in the future, therefore, serve as a reference when linking potential Roux limb dysmotility and symptoms after RYGBP. However, it must be emphasized that the set-up used in the present study did only cover a short part of the proximal Roux limb. In future studies on dysfunctional Roux limb motility, it is recommendable to use longer recording devices extending towards and preferably including the entero-entero anastomosis area.

In summary, the manometric picture of the oesophagogastro-Roux limb area in uncomplicated RYGBP patients was described. The oesophagogastric junction had an abdominal location, and aborally MMCs, with onset immediately distal to the GEA, appeared in the Roux limb of all study subjects during fasting. Food ingestion was associated with a modest intraluminal pressure increase of similar magnitude in the gastric pouch and the Roux limb. The food-induced increased intraluminal pressure did not correlate with weight loss nor with meal size or eating rate. The data indicate that the gastric pouch and the Roux limb behave as a common cavity but give no support to that the meal-associated increased intraluminal pressure influences meal size or weight loss.

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Conflicts of Interest Dr. Lönroth has received an unrestricted research grant from Johnson & Johnson Ethicon Surgical Care. Drs. Björklund and Fändriks declare that they have no conflict of interest.

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