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ORIGINAL ARTICLE

Roux-en-Y Limb Motility after Total Gastrectomy

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Abstract The Roux-en-Y stasis syndrome is a troublesome postgastrectomy syndrome. Although the era of gastric resection for peptic ulcer disease has almost come to an end, the increasing incidence of proximal gastric cancer and the outbreak of bariatric operations make the study of the motility of the Roux-en-Y limb (RYL) after gastric resection or gastroplasty very relevant.This study aims to evaluate the motility of the RYL after total gastrectomy using high-resolution manometry (HRM). We performed an HRM on 8 patients after total gastrectomy for proximal gastric cancer and Roux-en-Y reconstruction, 74±111 months after the operation. At the time of the study, all patients were asymptomatic without evidence of cancer recurrence.Peristaltic waves were noticed at the RYL in 3 (37 %) of the patients. The mean wave amplitude of the peristaltic waves was 63±29 (37–94) mmHg and 83±35 (42–104) mmHg at 3 and 7 cm below the esophagojejunal junction, respectively. Simultaneous waves were noticed in 6 (75 %) of the patients in 80±32 % (30–100) of the swallows of these patients. No patient presented with absence of motor activity detectable at the HRM. Our results show that: (1) esophageal motility is normal after total gastrectomy with Roux-en-Y reconstruction; (2) motor activity is always detectable at the proximal RYL, but peristalsis is abnormal in most patients; and (3) absence of peristalsis does not translate into symptoms.

Keywords Total gastrectomy · Roux-en-Y esophagojejunostomy · Roux-en-Y syndrome · Post-gastrectomy syndromes · Small bowel manometry · High-resolution manometry

Introduction

The Roux-en-Y syndrome is described as a troublesome post-gastrectomy syndrome caused by dysmotility of the Roux-en-Y limb (RYL) and consist of vomiting of food but not bile, postprandial pain, and nausea.[1] Although the era of gastric resection for peptic ulcer disease has almost come to an end,[2] the increasing incidence of proximal gastric cancer,[3] and the outbreak of bariatric operations[4] contribute to a significant number of gastric resections currently performed and make the study of the motility of the RYL very relevant.

Recently, high-resolution manometry (HRM) has replaced conventional manometry for the study of esophageal motility.[5] This technique is based on a solid-state catheter with multiple sensors that allows simultaneous and very precise recording from the upper to the lower esophageal sphincter. As compared to the conventional esophageal manometry based on water-perfused catheters, HRM allowed a precise and reproducible determination of many parameters and contributed to a better understanding of esophageal motility disorders such as achalasia.[6]

This study aims to evaluate the motility of the RYL after total gastrectomy using HRM.

Methods

Population

We studied 8 patients (62 % males, mean age 64±11 years) after total gastrectomy for proximal gastric cancer (D2 lymphadenectomy) and Roux-en-Y reconstruction. In all cases, the esophagojejunostomy was performed with mechanical staplers and the RYL measuring 45 cm. No attempt to create a large reservoir or neostomach (pouch) was done. The mean

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time from the operation to the study was 74±111 months (1–264 months). At the time of the study, all patients were asymptomatic, were able to eat an unrestricted diet, and had no evidence of cancer recurrence.

Esophageal Manometry

All patients underwent HRM (Given Imaging, Los Angeles, CA, USA) in which 36 circumferential pressure sensors spaced at 1-cm intervals were displaced along the catheter. Tests were performed after fasting for 8 h and medications that could interfere with esophageal or bowel motility were discontinued for at least 72 h before the study. Acquisition and data analysis were obtained via the dedicated commercial software (ManoScan and Manoview, Given Imaging). All catheters were inserted blindly *trans*-nasally and at least 7 (7 cm) sensors were placed into the RYL. Correct placement of the catheter was done by HRM analysis showing a complete esophageal peristalsis and absence of the "butterfly" sign denoting bending of the catheter. Ten wet swallows of 5 ml, spaced 30 s intervals, were given during the test.

The manometric parameters evaluated were: (1) UES pressure (normal value 34–104); (2) esophageal body: mean pressure at 3 and 7 cm above the esophagojejunal junction defined by the sudden stop of the esophageal peristaltic wave and/or diaphragmatic impression (normal value 43–152 mmHg), intrabolus pressure (normal value < 8.4 mmHg), distal contractile integral (normal value 500–5,000 mmHg/s · cm), esophageal body peristalsis (normal value > 80 %); and (3) RYL peristalsis and wave amplitude.

Ethics

The study was approved by the Institutional Review Board. Informed consent was signed by all individuals. There are no conflicts of interest. The authors are responsible for the manuscript, and no professional or ghost writers were hired.

Statistical Analysis

All variables are described as mean ± standard deviation (range).

Results

Upper esophageal sphincter (UES) basal pressure was 68±30 (25–115) mmHg. One (12 %) patient had a hypotonic UES and 1 (12 %) patient had a hypertonic UES.

Mean esophageal body pressure was 80±71 (35–237) mmHg. Two (25 %) patients had hypocontractility and 1 (12 %) hypercontractility. Peristaltic waves were present in 80±30 % (20–100) of the swallows. Bolus pressure was 4±12 (-4–23) mmHg, with 2 (25 %) patients with abnormal values. Distal contractile integral was 2,052±3474 (253–9,879) mmHg/s · cm, with 1 (12 %) patient with an elevated value and 1 (12 %) with a decreased value.

Peristaltic waves were noticed at the RYL in 3 (37 %) of the patients with a mean wave amplitude of the peristaltic waves of 63±29 (37–94) mmHg and 83±35 (42–104) mmHg at 3 and 7 cm below the esophagojejunal junction, respectively. Simultaneous waves were noticed in 6 (75 %) of the patients (Table 1). No patient presented with absence of motor activity detectable at the HRM.

Figure 1 shows the peristaltic patterns found in the RYL.

Discussion

Our results show that: (1) esophageal motility is normal after total gastrectomy with Roux-en-Y reconstruction; (2) motor activity is always detectable at the proximal RYL, but peristalsis is abnormal in most patients; and (3) absence of peristalsis does not translate into symptoms.

Roux-en-Y is still the preferred technique for reconstruction of the digestive tract after gastrectomy for gastric cancer[7] or morbid obesity[8] and after gastroplasty as a bariatric operation.[9] The Roux-en-Y reconstruction was described firstly in dogs by a German surgeon, Wolfler in 1881,[10] but popularized by Cesar Roux in 1897.[11] Alterations in gastric emptying after Roux-en-Y reconstruction have been noticed since 1975[12]; however, the term post Roux-Y delayed emptying syndrome was coined by Vogel et al.[13] in their classic experiments in dogs in 1981. In the past, the RYL syndrome was a strong drawback against the use of the Roux-en-Y reconstruction due to an incidence of up to 70 % after gastrectomy.[14] Modernly, the incidence of the syndrome seems to be irrelevant. Currently, most series do not report this complication, while others show a decreased incidence after distal gastrectomy for gastric cancer to only 15 %.[15,16] Furthermore, the syndrome has not been commonly described

Table 1 Manometric patterns of motor activity at the proximal Roux-en-Y limb

Patient	Percentage of peristaltic waves (%)	Percentage of simultaneous waves (%)	Percentage of failed waves (%)
1	10	0	90
2	10	0	90
3	50	50	0
4	0	30	70
5	0	100	0
6	0	100	0
7	0	100	0
8	0	100	0

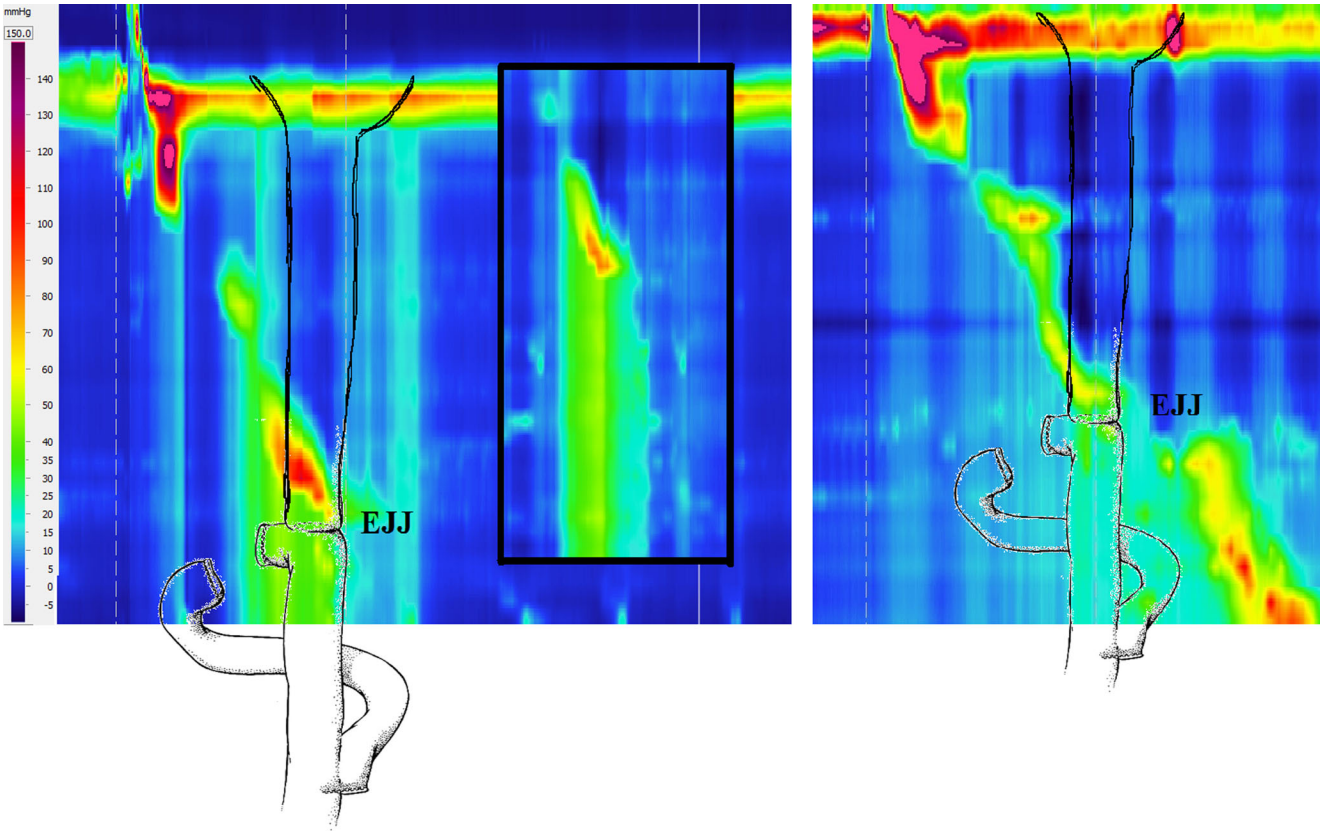

Fig. 1 Roux-en-Y limb motility patterns at the high-resolution manometry: simultaneous waves (*left*) and peristaltic waves (*right*). Esophageal body peristalsis is normal in both cases. Pressure magnitude is encoded in color corresponding to the scale shown at the *left side*. *EJJ* esophagojejunal anastomosis

after bariatric operations or total gastrectomy. This fact leads to the assumption that the syndrome was overdiagnosed or misdiagnosed, and in consequence, it is not linked to the putative interruption of the duodenal pacemaker and RYL dysmotility. In fact, several authors demonstrated that in most patients with clinical diagnosed RYL syndrome, after a careful reevaluation of these patients, the symptoms may be credited to other factors[17] such as delayed gastric emptying or mechanical obstruction.[18] Differentiating what they call the Roux-en-Y syndrome from the Roux-stasis syndrome, a phenomenon described originally and largely after peptic ulcer operations that was initiated by the utilization of a Roux limb with vagotomy and distal gastrectomy/antrectomy. Eventually, it became clear that the stasis was in the nonfunctional gastric remnant and that completion and near-total gastric resection was sometimes the only approach to relief: the Roux stasis syndrome was thus connected to a nonfunctional gastric remnant, not to the Roux limb itself after the remnant was removed.

Several methods may be used to assess motility of the small intestine[19] such as transit of radiolabeled food.[20] Intestinal manometry, however, provides a more comprehensive and detailed evaluation.[21] The manometric evaluation of the motility of the small intestine is a complex task. Different from esophageal motility, small bowel is not easily accessible for intubation; several qualitative and quantitative manometric data may be generated (such as amplitude of contractions, area under the curve, bursts during fasting, discrete cluster contractions, giant migrating contractions, motility index, phases I–III incidence, phasic contractions, prolonged contractions, propagation velocity, retrograde giant contractions, sustained uncoordinated pressure activity[19]); motor activity is present in the feeding as well as in the fasting state[19,22]; and most studies dealing with postprandial state were conducted with an intact stomach/pylorus.[21]

In our study, we applied HRM for the evaluation of the proximal RYL motility after total gastrectomy. HRM, due to its characteristics, seems to be a much better tool for the study of intestinal motility compared to conventional manometry even though literature data is still scarce. An elegant paper analyzed contractions of isolated rabbit small bowel with the aid of HRM and video mapping of the diameter of the intestine.[22] This paper allowed correlation between movements of the intestinal wall and intraluminal pressure showing that longitudinal muscle contraction can be detectable as subtle increases in intraluminal pressure, but the great majority of large propagating pressure events were associated with corresponding propagating circular muscle contractions and detectable by HRM.

Total gastrectomy was used in our study as the experimental model for the evaluation of the RYL due to the technical reasons (easy intubation of the intestine without the aid of endoscopy) and to eliminate gastric emptying as a confounding variable. In fact, Mathias et al.[23] showed with the aid of conventional manometry that RYL motility is close to normal in patients after total gastrectomy compared to abnormal motility during fasting and fed-state in patients submitted to partial gastrectomy. Also, only patients without a pouch or reservoir were studied since their presence may alter motility.[24] Interdigestive motility was not studied since the focus of the protocol was to evaluate food propagation and not food mixing with digestive and absorptive purposes.

Previous studies with conventional manometry[25] showed a more quiescent behavior of the RYL. Only one out of seven subjects converted to a fed-state motility pattern in the RYL after a liquid meal, and all seven subjects failed to convert to a fed state after a solid meal. Very interestingly, Haglund et al.[26] with the aid of scintigraphy and fluoroscopy did not find correlation between symptoms and motility patterns. This observation would suggest either (a) the Roux limb is no more than a conduit or (b) the symptoms come from the afferent limb—the latter of which was not evaluated in this study but could be evaluated as last scintigraphically using a hepatobiliary iminodiacetic acid scan and the former of which could be evaluated by a gastric liquid/solid emptying study.

Our study has some limitations, such as the small number of patients studied, since all of them were volunteers and the evaluation of the proximal part of the RYL only. Moreover, we choose to study only asymptomatic patients in order to determine reference values to evaluate symptomatic patients in future studies even though we showed that the absence of peristalsis does not translate into symptoms. In conclusion, we demonstrated that HRM may be used to evaluate proximal RYL motility and motility does not correlate with symptoms.

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