Motility of the stomach in health and disease. Review.

I. The normal motor function of the stomach

The first studies of the motor function of the stomach were associated with the discovery of X-rays. They helped identify the three main functions of the stomach: storing food eaten, crushing it, and emptying stomach contents into the duodenum. The stomach is located between the esophagus and the duodenum. In fact, it sits almost permanently in the close space between the lower esophageal sphincter (LES), which prevents reflux from the stomach into the esophagus, and the pyloric sphincter (pS), which controls gastric emptying. From a functional point of view, the stomach is divided into proximal and distal parts. The proximal part, including the fundus and the body of the stomach, provides reception and temporary storage of food. It regulates intragastric pressure and stimulates the tonic advancement of the chyme into the distal part. In addition, it provides space and time for pepsin and hydrochloric acid to act in the early stages of digestion. The fundus is characterized by tonic rather than peristaltic contraction. An important function of the proximal stomach is its ability to accommodate. More than a liter of food can enter the stomach without increasing intragastric pressure [1,2]. A study of pressure on volunteers showed that intragastric pressure decreases moderately after eating and returns to the initial level as soon as solid food ingredients penetrate the duodenum [3]. The motor function of the proximal stomach is regulated by reflexes: receptive relaxation and gastric accommodation. Receptive relaxation is manifested by a decrease in the tone of the proximal stomach during swallowing. For example, Shafik's study showed that «Pharyngeal distension produced a significant pressure drop of the corpus of the stomach ($p < 0.05$); the pyloric antrum show no response. Upper, middle, or lower esophageal distension produced gastric response similar to that evoked by pharyngeal distension" [4]. Stomach accommodation is described as a relaxation reflex of the proximal stomach in response to distension. Unlike receptive

relaxation, this reflex does not depend on the stimulation of the esophagus and pharynx. There is evidence that in humans the accommodation reflex is associated with the release of serotonin and activation of nitrergic motor neurons, as well as mediated by the vago-vagal reflex [2].

In the distal part of the stomach, a negatively charged membrane potential is determined, on which rhythmic depolarization at three cycles per minute is superimposed. The frequency and direction of electrical activity is closely related to the slow peristaltic wave. There is evidence that the slow wave is generated by the phase depolarization of Cajal interstitial cells. These cells are located on the greater curvature of the stomach. The slow wave propagates a little faster along the greater curvature so that the myoelectric activity "running" along the greater and lesser curvatures of the stomach reaches the pylorus simultaneously. Slow waves with three cycles per minute are observed both at rest and in the phase of active gastric motility. Neurohumoral activators increase the amplitude of the slow wave and this contributes to the crushing of food into finely dispersed. The regularities of the motor function of the stomach were investigated mainly with the manometric and X-ray studies.

Shafik et al showed that "gastric balloon filling with more than 20 ml of H_2O showed progressively increasing LES pressure up to 110-120 ml of gastric filling, beyond which the pressure exhibited no further increase upon incrementally increased gastric filling volume" [5]. The distension of the proximal stomach produced no pressure changes in the proximal stomach, pyloric antrum, or sphincter ($p>0.05$). Antral distension affected a significant rise in antral pressure, but not in the proximal stomach. A significant (pyloric) sphincter pressure decrease occurred only with antral distension volumes >50 ml [6]. Pyloric sphincter contraction and antral dilatation upon duodenal distension suggest a reflex relation. This reflex appears to prevent duodenopyloric reflux [7].

The results of X-ray studies are completely consistent with the manometric data. An increase in abdominal pressure during administration of a contrast agent causes an increase of the LES tone and its contraction in patients with GERD [8,9] **(Figure 1**).

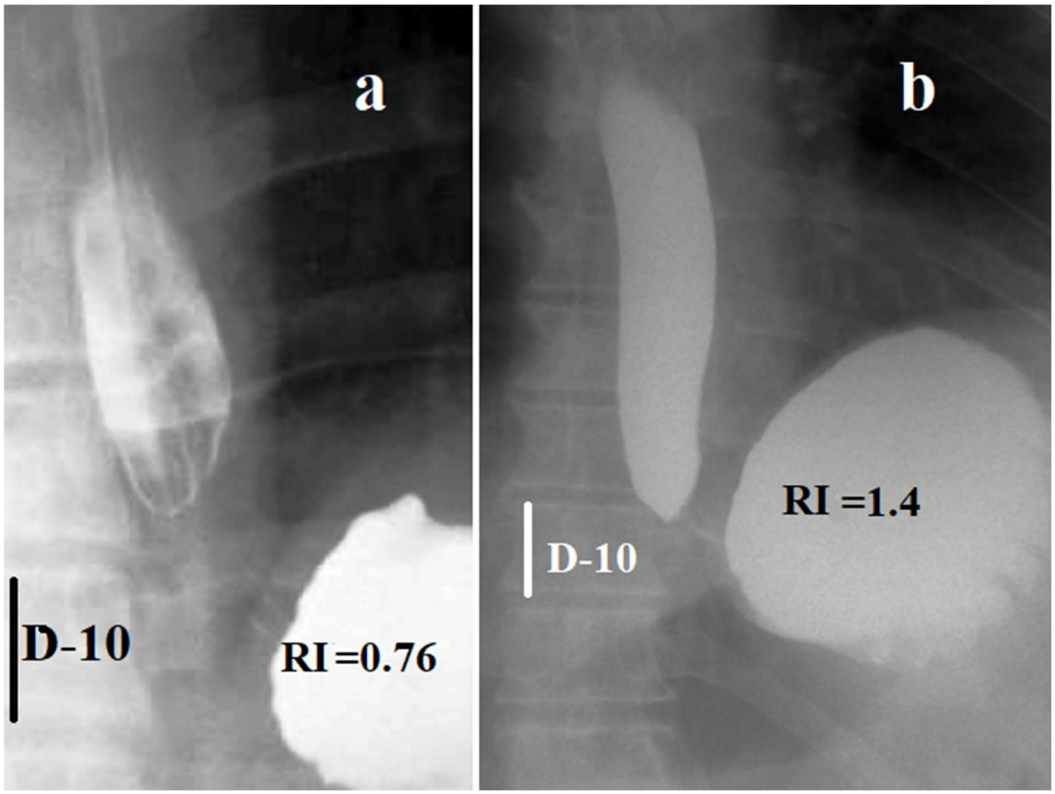

Figure 1. Radiographs of the EGJ in patients with GERD, performed with high pressure in the stomach. (a). Compression of the abdomen caused an increase in pressure in the stomach and resulted in a reflex contraction of the LES, which is defined as the distance between the barium in the esophagus and in the stomach. Although the esophagus is dilated relative to normal (1.0 versus 1.5 cm), and the length of the LES is shorter than the norm (2.5 versus 3.6 cm), the RI (reflux index is the ratio of the width of the esophagus to the length of the LES) is 0.76, which indicates a mild form of GERD. (b). Increased pressure in the stomach when lifting straight legs. The width of the esophagus is 2.5 cm, and the length of the LES is 1.9 cm. RI = 1.4. A higher RI indicates a more severe GERD.

Since antral distension causes a significant rise in antral pressure, but not in the proximal stomach [6], therefore, two cavities with different pressures arise in the stomach. X-ray studies show that in a horizontal position every 3-5th peristaltic wave closes in the antrum and detaches a part of the contrast agent to form a closed cavity between the antral sphincter and the pyloric sphincter. Continuing

to contract antral systole causes a rise in pressure to a threshold level, which leads to the reflex opening of pS and injection of the bolus into the duodenum [10] **(Figure 2**).

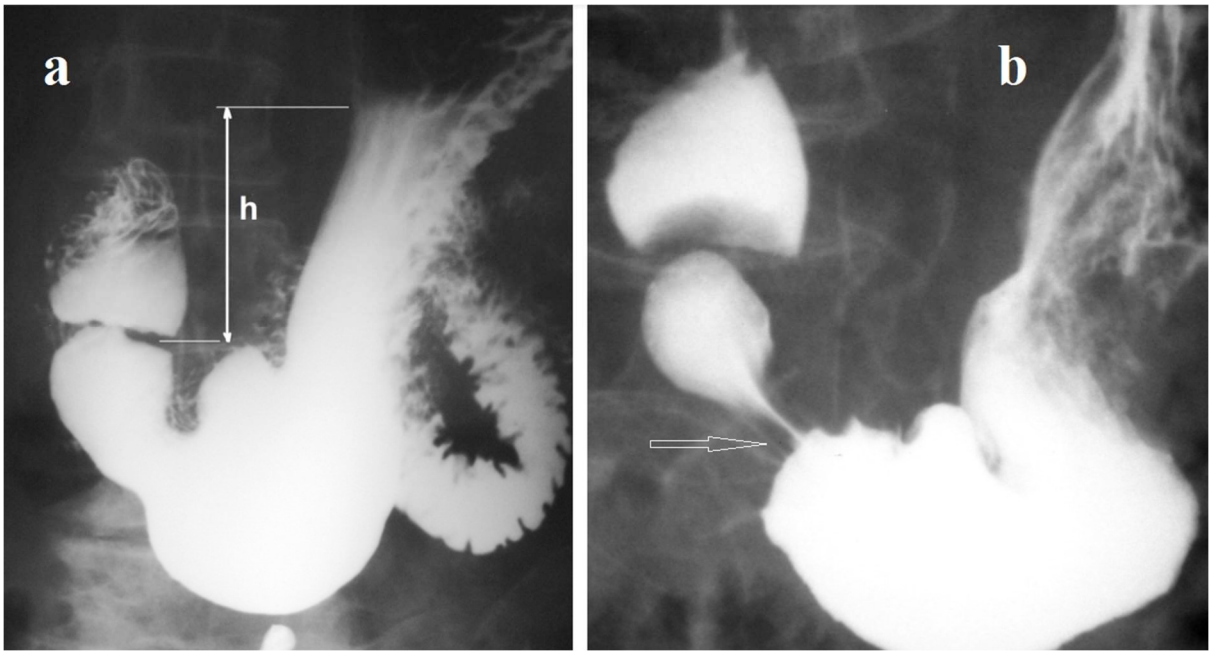

Figure 2. Options for evacuation from the stomach. (a) In the upright position, the hydrostatic pressure of the liquid column (h) between the liquid level in the proximal part of the stomach and the pyloric sphincter creates a threshold pressure for the reflex opening of pS and filling of the duodenal bulb. (b) In a horizontal position, because of contraction of the antral sphincter (arrow), a closed cavity was formed, which a result of continued peristalsis, injects a bolus into the duodenal bulb.

The reflex pyloric sphincter contraction and antral dilation upon duodenal distension is of great importance for the normal function of the stomach and duodenum. Thanks to this reflex, the bolus is evacuated in portions, the volume of which is equal to the capacity of the duodenal bulb. However, for the pressure necessary to close the pS to rise in the duodenal bulb, the post bulbar sphincter must close (Figure 3). Thus, as soon as the bulb is filled with food, the post bulbar sphincter contracts in response to its irritation with hydrochloric acid. The pressure in the bulbus rises, which leads to a contraction of pS and the termination of evacuation.

Only every 3-5th peristaltic wave of the antrum ends with the formation of a closed cavity and the release of a bolus into the duodenum. The rest of the waves do not close, and then, during the contraction of the antrum, its contents are thrown retrogradely into the body of the stomach, mixing the gastric contents. At this moment, pS is in a closed state **(Figure 3.a**). Its length as a non-contrast zone between the stomach and the duodenal bulb was measured in patients of different ages **(Table 1**) [10].

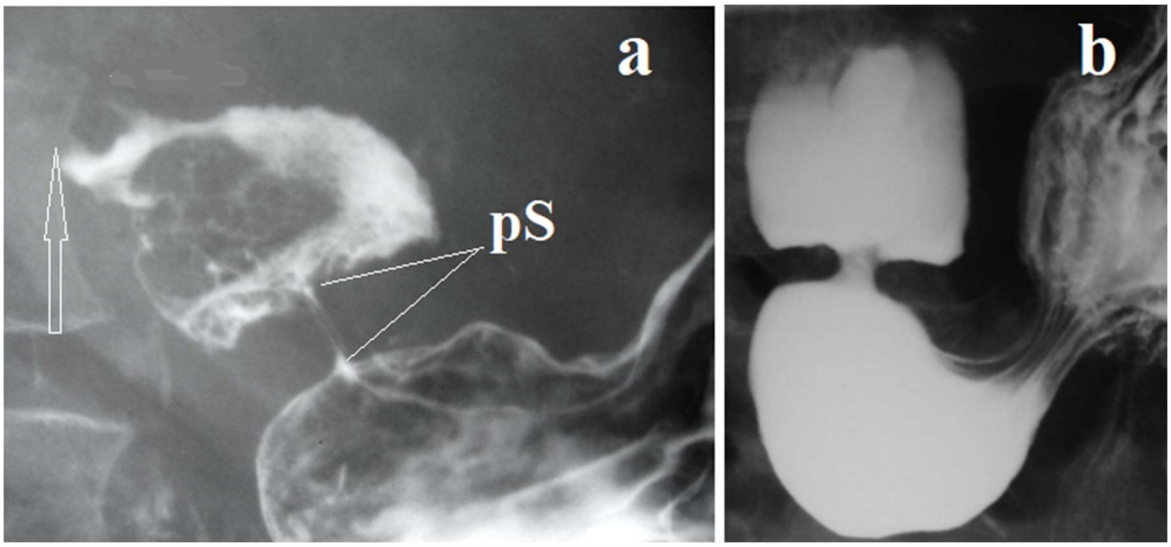

Figure 3. Radiographs of the gastro-duodenal junction. (a) The pyloric sphincter (pS) is in a closed state. The arrow indicates the location of the contracted post bulbar sphincter. The width of the bulbus base is almost equal to that of the opposite side of the stomach. (b) At the moment of evacuation of barium from the stomach, the pS widened and its length decreased.

Table 1. The length of the pyloric sphincter at different ages (cm).

Age	Up to a year	1-3 years	4-7 years	8-10 years	11-15 years	21-64 years
limits	0.2-0.3	0.3-0.4	0.5-0.6	0.5-0.8	0.6-0.8	0.6-0.8
M±m	0.21±.01	0.36±.04	0.56±.03	0.66±.02	0.72±.09	0.72±.02

The pyloric sphincter, as well as the LES and the internal anal sphincter, are not detected during anatomical examination [11]. However, the contraction of muscle fibers in the pS zone differs from the motor activity of the antrum and the duodenal bulb [6.7,12]. From a physiological point of view, the duodenal bulb belongs to the stomach. It, like the stomach, originates from the foregut. Its mucous membrane is similar in structure to the mucous membrane of the antrum. The post-bulbar part of the duodenum originates from the midgut and has a structure characteristic of the small intestine [13].

The empty bulb of the duodenum has a small diameter round shape, characteristic of the small intestine. It takes on the typical triangular shape of a bulb when filled with chyme from the stomach. At the time of filling the bulbus, the width of the opened pS ranges from 2 to 5 mm, and its length is significantly shorter than the age norm. The formation of the bulb with the simultaneous opening and shortening of pS is explained by the structure of the muscle fibers. Superficial longitudinal muscle fibers stretch from the wall of the antrum, pass through the pylorus to the bulb. Deep longitudinal muscle fibers extend from the antral wall, penetrate through the entire thickness of the pylorus, and attach to the connective tissue of the submucosal layer of the bulb [14] (**Figure 4**).

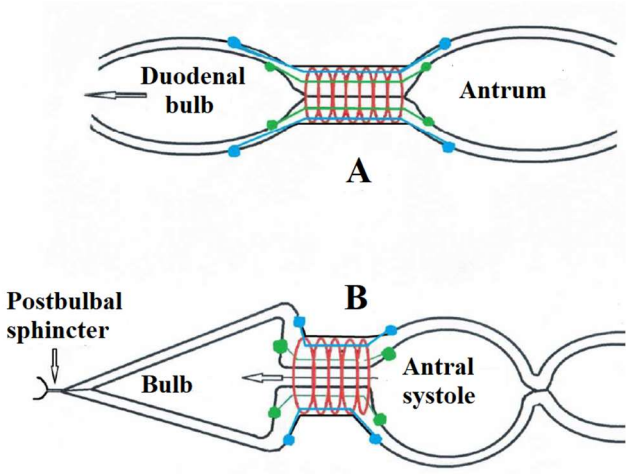

Figure 4. The scheme of the pyloric sphincter functioning. (A) It is closed. (B) At the time of antral systole, there is a contraction of the longitudinal muscles

extending from the antrum of the stomach to the base of the bulbus. They stretch the base of the bulb like parachute slings. The walls of the antrum facing the bulb are stretched to the same extent. The wider the base of the bulb, the wider the "shoulders" of the antrum. These fibers pass through the pS and therefore, when they contract, stretch its walls, actively creating a channel for the bolus to pass.

In accordance with this hypothesis, pS opening occurs not only because of its relaxation but it is an active process.

Endocrine factors affect the tone and volume of the proximal stomach. For example, cholecystokinin, secretin, vasoactive intestinal polypeptide, gastrin, somatostatin, dopamine, gastrin-releasing peptide, glucagon, and bombesin induce relaxation, while motilin increases fundic pressure [1].

The stomach is a chemical plant producing harsh chemicals. Its mucous membrane has a unique ability to resist the aggression of the substances. It secretes and excretes hormones that, together with the nerve vagus and exogenous factors, regulate the secretion of chemicals depending on the quantity and quality of food [15].

1) One important hormone secreted by the stomach is ghrelin. Ghrelin is orexigenic (increases appetite) and serum concentrations of this hormone are elevated before a meal and suppressed postprandially. It is produced by endocrine cells in the stomach and regulates appetite by crossing the blood-brain barrier to bind to receptors located on cells in the hypothalamus, as well as by signaling through vagal afferent nerve fibers.

2) The stomach also produces small amounts of the anorexigenic hormone leptin, although the main source of leptin in adipose tissue.

3) Gastrin is secreted by G cells, which are predominantly located in the antrum of the stomach. It has well-known functions in regulating gastric acid secretion. Gastrin is secreted in response to food ingestion and binds to CCK2 receptors on gastric enterochromaffin-like cells, stimulating them to release histamine, which

in turn binds to H2-receptors on parietal cells to stimulate them to secrete hydrochloric acid. The secretion of gastrin is inhibited by somatostatin, which is secreted by D cells within the stomach and the intestine.

For example, many patients who take regular proton pump inhibitors (PPIs) have normal fasting serum gastrin concentrations, while others develop hypergastrinaemia. The latter group includes patients with concomitant atrophic gastritis and/or impaired gastric emptying [15].

Nature has created a unique chemical factory for the processing and digestion of food, combined with a system to protect the digestive system from aggressive gastric juice. It is obvious that despite the progress in understanding this system, we still do not know many of its elements. However, knowing the principles of the functioning of this system and its unique rationalism, it is possible to hypothesize new ways for scientific research.

Postnatal ontogenesis of the stomach. In newborns, the stomach has the shape of a retort with a clear distinction between the proximal part (fundus + body), in which milk accumulates, and the distal part (antrum), through which milk passes into the duodenum (Figure 5.a, b).

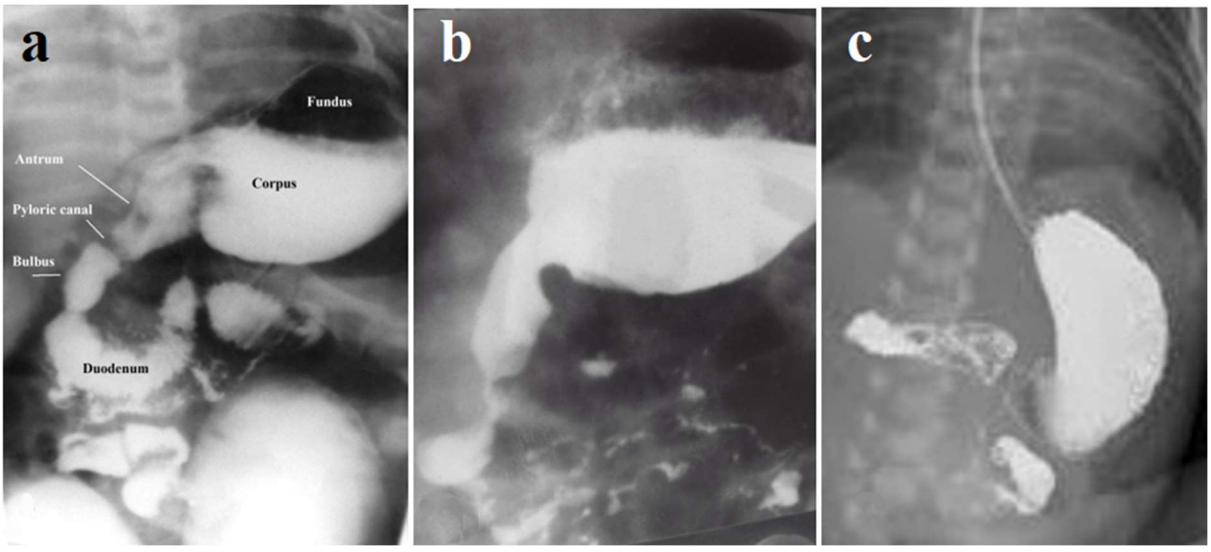

Figure 5. The gastroduodenal radiographs in infants up to 1 month of age. (a, b) Infants with regurgitation. (c). Newborn with malrotation.

The following is hypothesis for the physiology

of the stomach in infants.

1. The stomach capacity of a newborn is small. The volume of the stomach is constantly increasing to ensure the rapid growth of the baby This is due to the stretching of the stomach with ever-increasing volumes of milk. The baby spits up excess milk. This is a normal physiological condition. Gradually, the stomach takes on the shape of an adult stomach with a sagging of the greater curvature below the bulb (Figure 5.c).

2. Milk contains all the necessary ingredients for normal development. The gastric mucosa does not secrete hydrochloric acid since there is no need for it. While the baby is consuming breast milk, lactase is secreted in the duodenum of the intestine, which breaks down lactose into galactose and glucose.

3. Adding food products that require chemical processing leads to the release of hydrochloric acid. In some infants, the production of lactase then stops. In such cases, lactose cannot be absorbed in the intestinal wall. As shown by the analysis of such patients, lactose intolerance causes hypersecretion of hydrochloric acid. Probably, lactose, acting on the mast cells of the small intestine, causes the release of a mediator (histamine?), which stimulates the release of hydrochloric acid through a known chain [16].

4. Infantile colic occurs when physiologic regurgitation occurs with low pH of gastric contents. The acid, burning the stomach, causes severe pain and inflammation in the esophagus. This leads to the dilation of the esophagus and weakness of the lower esophageal sphincter. By 6 months, the volume of the stomach comes in line with the volume of a single feed. The regurgitation stops and the child becomes calm. The symptoms of GERD reappear many years later, due to the weakness of the LES [17].

II. Pathological physiology of stomach diseases

Hypertrophic pyloric stenosis. Infantile hypertrophic pyloric stenosis (PS) is characterized by hypertrophy and hyperplasia of the pyloric muscle, causing pyloric channel narrowing and elongation. The rigidity of the muscle is increased, which is characterized as an "olive" (**Figure 6)**. The pylorus hypertrophies after birth and causes progressive gastric outlet obstruction in infants between 2 and 6 weeks of age. The antral fold hypertrophy first noted in them at 10 days of age [18]. The hyperplastic pyloric mucosa constitutes approximately one-third of the cross-sectional diameter of the pyloric mass and fills and obstructs the pyloric canal [19].

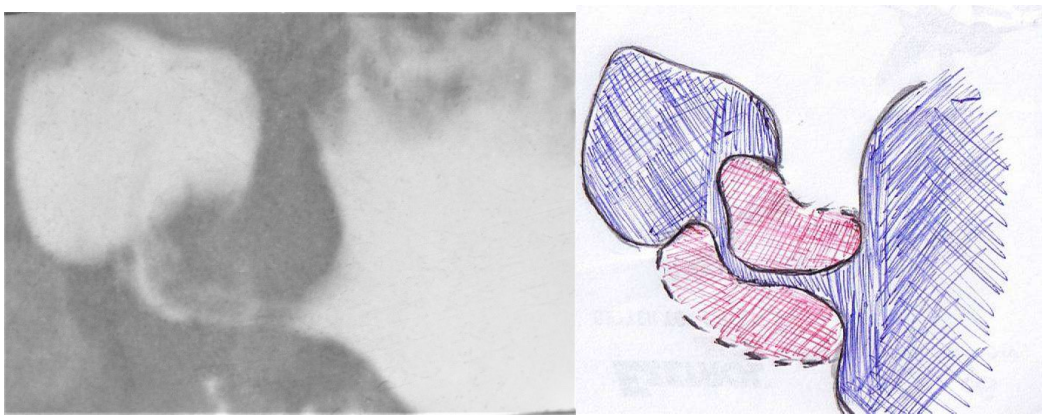

Figure 6. X-ray of a baby with pyloric stenosis and a diagram for it.

The clear boundaries of the pyloric olive in sonographic examination indicate that the muscles of the pyloric canal are separated from the muscles of adjacent sections. Takeuchi et al in esophagogastric endoscopy of patients with PS showed a 100% incidence of esophagitis. Histological study of the esophageal mucosa showed evidence of esophagitis in 86% of patients. Preoperative pH monitoring showed gastroesophageal reflux in all infants [20].

The etiology of PS. All studies confirm that PS occurs in response to hyperacidity of gastric juice, which leads to spasm of the pyloric canal, long-term contraction of which causes its hypertrophy [18-24]. Hyperacidity is typical for infants and many authors associate it with a high level of gastrin. The mean serum immunoreactive gastrin (IRG) level of normal infants (103 +/- 9 pg/ml (mean +/- SEM) exceeded that of normal adults (28 +/- 5 pg/ml). The preoperative mean serum IRG level in PS infants (256 +/- 26 pg/ml) was significantly higher than that of both normal infants and vomiting infants without PS (93 +/- 9 pg/ml) [22]. Hormonal regulation of hyperacidity is obvious, but it not fully understood, as some studies indicate an increase in somatostatin but not gastrin. Somatostatin is known to inhibit the actions of inhibitory neurotransmitters in the pylorus and may explain the development of pylorospasm [23].

There are several factors that significantly influence the incidence of PS. (1) family history, which is possibly related to the inherited high parietal cell mass [25]; (2) male gender; (3) formula-fed infants were 1.36 times more likely to develop PS compared with exclusively breastfed infants [26]; (4) exposure to erythromycin (between 3 and 13 days of life) was associated with a nearly 8-fold increased risk of PS [27]. This is due to the fact that erythromycin stimulates antral activity [28]. Thus, PS arises as work-induced hypertrophy that goes through the pyloric spasm stage. These changes are caused by hydrochloric acid hypersecretion or other factors that stimulate antral activity. Pyloric muscle thickness (PMT) and pyloric diameter (PD) in healthy infants was 2.0 mm and 10.0 mm. In infants with an initial diagnosis of PS, but with a final diagnosis of no PS the mean figures were 2.4 and 11.0 mm, and in 21 infants with PS, confirmed at surgery, the figures were 4.0 and 14.0. The pyloric dimensions in the 3 groups differed significantly. The larger-than-normal pyloric dimensions in the "no PS" group suggest that some of these patients suffered from milder

degrees of PS [29]. The X-ray picture of spasm with moderate thickening of the pyloric canal is shown in **Figure 7.**

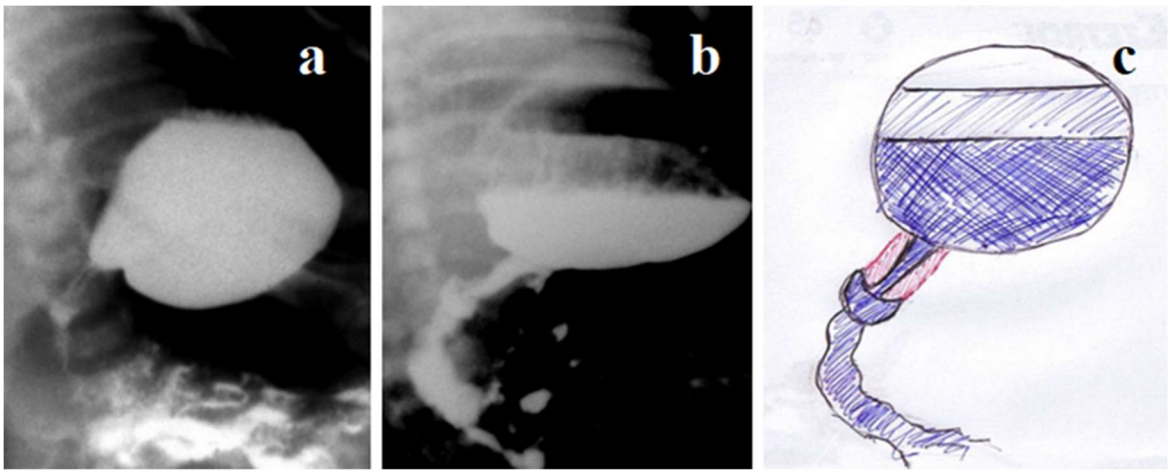

Figure 7. Radiographs of infants with recurrent vomiting (a-b) and (c) Schematic to Figure b. An infant stomach, where the proximal part of the stomach is located above the duodenal bulb, indicates an early stage of the development of the disease. The pyloric canal is narrow and long. Delayed gastric emptying. Diagnosis: pylorospasm. Successful treatment with atropine.

The age of presentation of reflux symptoms and infantile colic parallel those of PS. It is proposed that this is because PS and, at least some cases of reflux, share the same cause-a temporary hold-up at the pyloric sphincter owing to acid-provoked hypertrophy of the pyloric sphincter [24]. Differential diagnosis of PS includes pylorospasm. The gastroesophageal reflux is a complication in both cases (PS and pylorospasm) as a result of hypersecretion of the stomach and increase pressure in it. Atropine sulfate is a very effective, cheap, safe, and perhaps more acceptable treatment option for PS [30,31]. The prevailing opinion is that the mechanism of atropine sulfate in PS therapy mainly involves a cholinergic blocking agent with potent antimuscarinic activity that decrease peristaltic contraction by relaxing the pyloric smooth muscles [31]. It is difficult to imagine that atropine can change the tone of the pyloric olive muscle with a cartilaginous consistency. Meanwhile, it is known that atropine actions on the parasympathetic nervous system inhibit salivary and mucus glands, including gastric secretion. It is more likely that atropine reduces the volume of

hypertrophied mucosa, which occupies a third of the thickness of the pylorus, and thus eliminates canal obstruction. On the other hand, atropine reduces the tone of the LES and aggravates GERD. There are reasons to try modern drugs that reduce gastric acid secretion including block gastrin secretion.

In adults the term `gastritis' defines any histologically confirmed inflammation of the gastric mucosa. It is usually classified as acute or chronic. Most gastric mucosal inflammation is self-limiting (clinically acute) and cau ses no permanent anatomical changes. Chronic gastritis has different etiologies, but its worldwide epidemiology overlaps that of H. pylori infection. H. pylori infection is the major determinant for gastric cancer, gastric ulcer, and duodenal ulcer.

- All three diseases affect mostly adults, although infection with H. pylori is generally acquired during childhood.

- In H. pylori-associated gastritis, atrophic changes occur earlier at the transitional mucosa of the angulus, later involving the distal stomach (antrum), before spreading to the proximal oxyntic mucosa. It takes years for non-atrophic inflammatory disease to progress to its atrophic counterpart, with a consequent rising prevalence of atrophic gastritis with ageing.

- Histology distinguishes two main phenotypes of gastritis: non-atrophic and atrophic. Gastric mucosal atrophy is defined as the loss of `appropriate' glands, and it is consistently recognized as the `cancerization field' for non-hereditary (so-called `epidemic') intestinal-type gastric adenocarcinoma [15].

The published samples of gastric motility in adults are assessed by the authors as probabilistic but not natural because the results of some authors contradict others. It is very difficult to determine the normal physiology of the stomach since from childhood when the stomach is infected with H. pylori until the manifestation of atrophic gastritis, pathological changes increase in the stomach that are not manifested by symptoms. Feelings of fullness, bloating, nausea, and

pain are characteristic also for GERD and should not be judged as the fullness of the stomach. Upper GI motility is characterized by the recurrent contractility pattern of the migrating motor complex (MMC) but the role of the MMC has remained unclear [15]. The classical concept that "gastric accommodation serves to prevent a rise in intra-gastric pressure during food intake" was recently challenged [32]. High-resolution manometry allows gastric manometry without technical limitations found on conventional manometry; however, studies are still on the phase of understanding the normal findings [33]. These examples explain why the study of the gastric motility is not applied in practical gastroenterology.

Gastroparesis (GP) is a disorder characterized by delayed gastric emptying of solid food in the absence of a mechanical obstruction of the stomach, resulting in the cardinal symptoms of early satiety, postprandial fullness, nausea, vomiting, belching, and bloating. Diagnosis of GP is based on the measurement of delayed gastric emptying via gastric scintigraphy or breath testing. It is assumed that gastroparesis can have idiopathic, diabetic, iatrogenic, post-surgical, or post-viral etiologies. The number of patients with idiopathic GP is significantly higher compared to all other causes. Since epigastric pain, early satiety, and abdominal fullness are typical symptoms of GP but can also be due to gastroduodenal ulcers or gastric cancer, all measures for the diagnosis and treatment of GP are carried out after excluding diseases of an organic nature [34,35].

The following are excerpts from review articles on gastroduodenal dyskinesia.

1. Disturbances of gastric and duodenal motor functions such as gastroparesis and functional dyspepsia are not differentiated on clinical symptoms. For example, of all patients with idiopathic gastroparesis, 86% met the criteria for functional dyspepsia.

2. In gastroparesis, research has focused on the role of macrophages in the loss of interstitial cells of Cajal, and on the role of pyloric resistance as a target for therapy, using botulinum toxin injection and gastric per-endoscopic pyloric myotomy. Research of the functional dyspepsia focuses on duodenal mucosal alterations.

3. Accelerated, normal, and delayed gastric emptying cannot be differentiated reliably based on the type or severity of gastrointestinal symptoms,

4. Several additional factors other than a global delay in gastric emptying — such as antral distension, antral hypomotility, gastric dysrhythmias, visceral hypersensitivity, or psychological disturbances — could explain, in part, the symptoms experienced by patients with gastroparesis.

5. To obtain a more specific symptom pattern and a better separation from functional dyspepsia with delayed emptying, gastroparesis has been proposed to require a stricter definition (for example, >3 standard deviations above the mean value in healthy volunteers).

6. Current treatment options of dietary management, prokinetics agents, antiemetic agents, and symptom modulators do not adequately address the clinical need for idiopathic gastroparesis [35,36,37].

Analysis of the literature indicates that "Gastroparesis" and "Functional dyspepsia" (FD) are not diagnoses, since, firstly, there is no data on the etiology, pathological physiology, and pathogenesis of these conditions. Secondly, there are no specific symptoms, since the above symptoms are typical for GERD, gastritis, duodenitis, and ulcerative lesions of the stomach and duodenum. To differentiate GP from FD, suggested assumptions (>3 standard deviations above the mean value in healthy volunteers are) are not valid in science. Third, there is no specific treatment for these disorders.

The name (pathophysiology) of this functional state is based on the following provisions: "Gastroparesis (GP) is a disorder characterized by delayed gastric emptying of solid food in the absence of a mechanical obstruction of the stomach". Obviously, that a mechanical obstruction means ulcerative deformity, fibrous stenosis, membrane. However, a decrease in the diameter of the pyloric sphincter also corresponds to this definition, since the smaller the diameter, the less volume of the chyme passes during the antral systole (**Figure 8**).

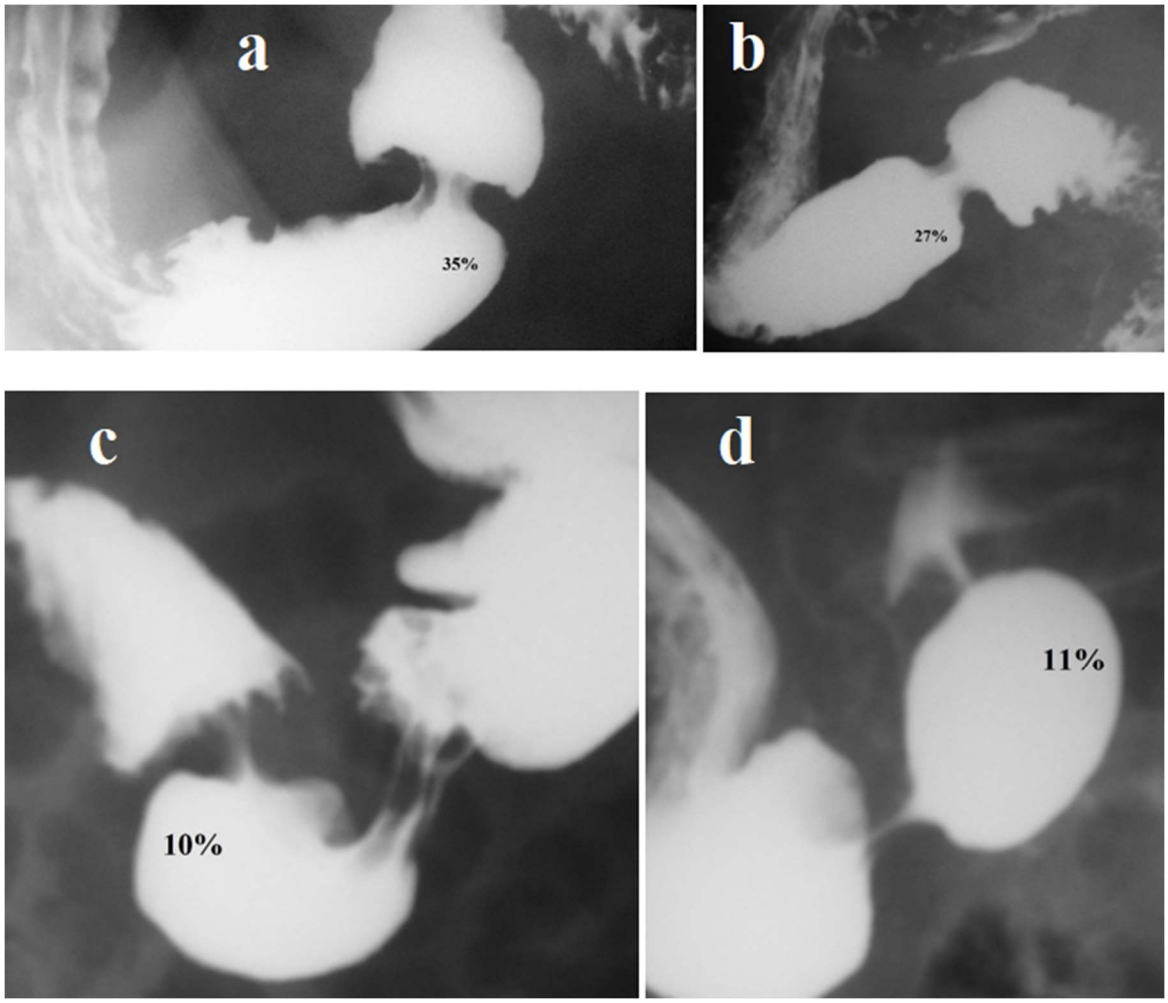

Figure 8. Radiographs of the gastroduodenal zone in the elderly with symptoms of dyskinesia of the digestive tract. The figures show what percentage is the width of the pyloric sphincter (PS) of the width of the base of the duodenal bulb during antral systole. (a-b). PS is wide (27-35%) and short. In these cases, the body of the stomach is almost empty of contents, which indicates a rapid evacuation from the stomach. (c-d). PS is narrow (10-11%) and long, and the stomach contains a

large amount of barium, which indicates a slow evacuation of barium from the stomach.

It should be noted that on each radiograph there are X-ray symptoms of gastroduodenitis. Another reason for the slow evacuation of the stomach may be a spasm of the pyloric canal (not PS), i.e. pylorospasm (**Figure 9**).

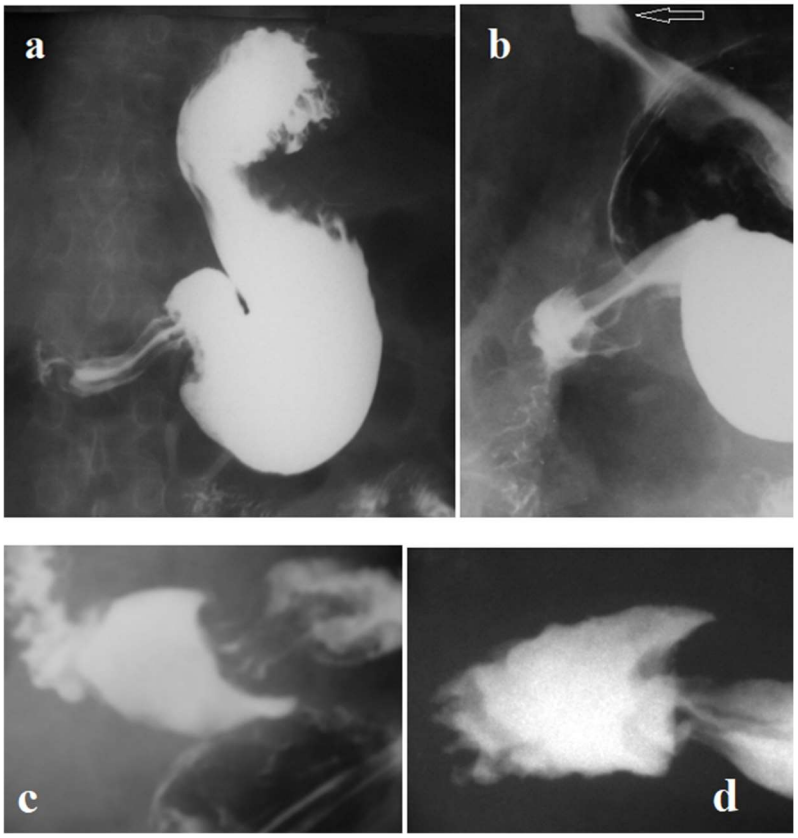

Figure 9. (a-b). In both cases, there is a spasm of the pyloric canal about 4-5 cm long. (b) The reflux was recorded into the phrenic ampulla (arrow)Simultaneously with pylorospasm. (c-d). Mucosal folds at the site of the pyloric sphincter.

Analysis of the literature and our own observations indicate that the etiological factor that eventually causes the symptoms described above is the hypersecretion of hydrochloric acid, which is out of control of the sphincters. The weakest link in this system is the EGJ. Therefore, GERD and esophagitis are usually the first sources of pathological symptoms. Since gastroscopy without histology does not allow diagnosing esophagitis, and pH-metry diagnoses only very severe forms of

GERD, a false idea arose about "idiopathic" elusive functional states (gastroparesis and functional dyspepsia) [38]. Symptoms of duodenitis and gastritis, which occur at an older age, hardly differ from symptoms in GERD. The severity of the symptoms depends on the duration of the disease, the aggressiveness of the gastric juice, and the most affected area.

The inflammatory process in the stomach wall (gastritis) causes the loss of interstitial cells of Cajal, which leads to impaired gastric accommodation reflex, as well as antral distension, antral hypomotility, and gastric dysrhythmias. As shown above, the pyloric resistance is also due to gastritis, which results in increased tone, mucosal hypertrophy, and rigidity of the pyloric canal and pyloric sphincter.

Lu et al on a large material showed that 3.8% of patients after fundoplication underwent surgical treatment of gastroparesis [39]. However, in many patients with the same symptoms, the diagnosis of gastroparesis was not confirmed. We have described a method for dilating the pyloric sphincter in patients with GERD by swallowing a tablet with a diameter of 2.3-3 cm. (**Figure 10**) [40]. The disappearance of symptoms was found in most patients. This method can be useful in the treatment of patients with hydrochloric acid hypersecretion.

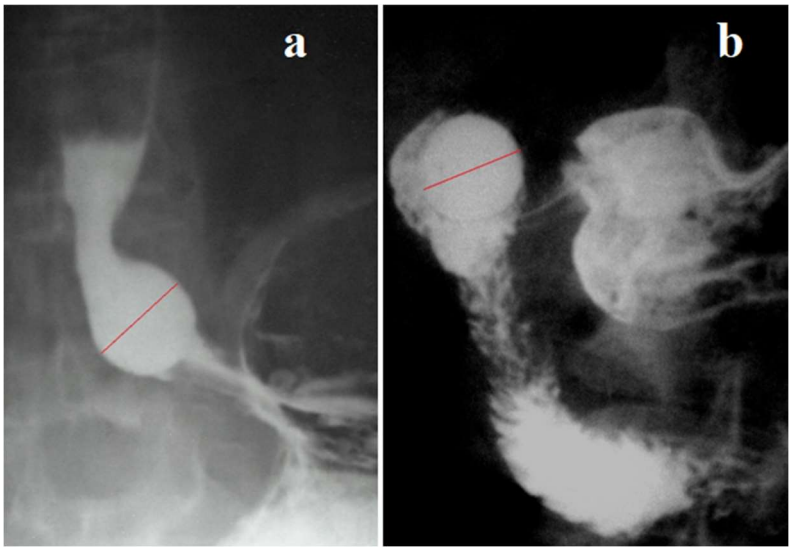

Figure 10. Passage of a tablet with a diameter of 2.3 cm through the LES and the pyloric sphincter. (a). The pill stopped over the LES. (b). A strong peristaltic wave of antral systole pushed the pill through the pyloric sphincter into the duodenal bulb.

Conclusion The cause of GERD, esophagitis, gastritis, duodenitis, ulcers of the esophagus, stomach, and duodenum as well as tumors of the esophagus and stomach is the aggressiveness of hydrochloric acid. Civilizational nutritional characteristics (rapid transition to artificial feeding of babies, overeating), and genetic factors (allergies, food intolerance) cause hypersecretion of hydrochloric acid and gradual damage to the defense mechanisms.

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