Unusual causes of pediatric gastric outlet obstruction. Utility of ultrasound

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Abstract
The stomach filled with liquid is easily observed by ultrasound (US) exam. The US scan protocol includes longitudinal and transversal views of the stomach, evaluating the muscular wall thickness (normal up to 3mm) and the gastric outlet. Causes of gastric outlet obstruction can be intrinsic, extrinsic or inherent to the stomach wall. In children, the most common cause is hypertrophic pyloric stenosis. The aim of this study is to show the usefulness of ultrasonography (US) in the diagnosis of gastric outlet obstruction of uncommon cause.

We report the cases of 7 patients aged 9 months to 12 years old, evaluated at our hospital between 2009 and 2012, who presented with gastric outlet obstruction symptoms. US showed thickening of the stomach muscular wall, filling of the stomach lumen or a mass in close relationship with the stomach wall. Granulomatous disease, gastric duplication with heterotopia, focal intestinal metaplasia, chronic gastritis, Burkitt lymphoma, duplication cyst, pancreatic ectopic tissue and bezoars were found in our series.

Gastric outlet obstruction (nonbilius emesis) in children is an entity that must be studied in detail by US, including the pyloric channel and the gastric antrum. Endoscopy-guided biopsy is conclusive, in most cases avoiding the need for an upper GI study. A previous CT scan was done in many cases before the histological diagnosis.

Keywords: gastric outlet obstruction; vomiting; ultrasonography; child

Introduction
Pediatric gastric outlet obstruction (GOO) encompasses a broad spectrum of conditions that prevent the passage of gastric contents into the duodenum. Nausea and no bilious vomiting are the characteristic symptoms¹.

GOO may be due to congenital lesions, such as atresia and pyloric and antral membranes, gastric duplication and aberrant pancreatic tissue, or to acquired causes such as hypertrophic pyloric stenosis, pylorospasm, gastric volvulus, foreign bodies, gastric tumors, peptic ulcer disease, chronic gastritis or retrograde duodenogastric intussusception². In children, the most common cause is hypertrophic pyloric stenosis¹.

The aim of our paper is to report a series of cases with GOO of unusual etiology in children and highlight the usefulness of ultrasound (US) in providing guidance on the diagnosis of patients presenting the aforementioned symptoms. The study was performed by different sonographers with over 3 years’ experience, which was not relevant for the outcome.

The stomach can be evaluated by ultrasound when the lumen is adequately distended with fluid. In our series, the amount of fluid used depended on the patient’s age and tolerance, being on average 200 ml. In patients with gastric intolerance at the time of the scan, fluid was administered by a nasogastric (NG) tube.

We report a series of 7 patients with an age range between 9 months and 12 years of age, who had GOO of unusual etiology. Patients were evaluated at our hospital between 2009 and 2012, and we reviewed the images obtained, the diagnosis and the treatment administered (table 1).

Case reports

Case 1
A twelve-year old boy presented with alimentary vomiting
and abdominal pain of 23 hours duration. An abdominal ultrasound showed an epigastric and extrahepatic cystic lesion measuring 4.2 x 3.9 x 4 cm with a wall having a hypoechoic outer layer and an echogenic inner layer, with anechoic content. The lesion was consistent with a duplication cyst. The evaluation was completed with a computed tomography (CT) that confirmed the presence of a thick-walled cyst with fluid content. This lesion enhanced after intravenous contrast administration and was located in the posterior wall of the antropyloric region, displacing forward and causing compression of the lumen. No passage of oral contrast to the distal area was noted. Resection was performed by laparoscopy and the pathology examination confirmed a duplication cyst with gastric heterotopia and focal intestinal metaplasia (fig. 1).

**Case 2**

A nine-month girl presented with vomiting and abdominal distension. An ultrasound showed a rounded and anechoic lesion of cystic appearance measuring approximately 1.3 x 0.8 cm, in contact with the posterior wall of the pylorus, which generated dilatation with retention of gastric contents. This finding was consistent with a duplication cyst. The girl also underwent an upper gastrointestinal (GI) series that showed a stomach with peristaltic and antiperistaltic movements, and then a CT scan that showed a cystic image in the antropyloric region, in close contact with the posterior wall. Finally, an endoscopy detected a rounded mass protruding towards the lumen in the antropyloric region. Surgery and resection was performed, with a diagnosis of duplication cyst with ectopic pancreatic tissue (fig. 2).

**Table 1:** Characteristics of the study population.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Chief complaint</th>
<th>Age and gender</th>
<th>Baseline imaging</th>
<th>UGI endoscopy</th>
<th>Final diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vomiting</td>
<td>12 years; M</td>
<td>No US/CT</td>
<td>No</td>
<td>Duplication cyst with gastric heterotopia</td>
<td>Surgery</td>
</tr>
<tr>
<td>2</td>
<td>Vomiting</td>
<td>9 months; F</td>
<td>No US/UGI series/CT</td>
<td>Yes</td>
<td>Duplication cyst with ectopic pancreatic tissue</td>
<td>Surgery</td>
</tr>
<tr>
<td>3</td>
<td>Vomiting</td>
<td>10 years; F</td>
<td>Trichophagia US/UGI series</td>
<td>Yes</td>
<td>Trichobezoar</td>
<td>Surgery</td>
</tr>
<tr>
<td>4</td>
<td>Vomiting</td>
<td>6 years; M</td>
<td>Use of NSAIDs and melena US</td>
<td>Yes</td>
<td>Chronic inactive gastritis</td>
<td>Dilatation</td>
</tr>
<tr>
<td>5</td>
<td>Vomiting</td>
<td>5 years; M</td>
<td>Chronic granulomatous disease US/UGI series</td>
<td>Yes</td>
<td>Lymphocytic infiltrate due to baseline condition</td>
<td>Medical therapy</td>
</tr>
<tr>
<td>6</td>
<td>Vomiting</td>
<td>9 years; M</td>
<td>Primary immuno-deficiency US/CT</td>
<td>Yes</td>
<td>Chronic inactive gastritis</td>
<td>Medical therapy</td>
</tr>
<tr>
<td>7</td>
<td>Vomiting</td>
<td>2 years; M</td>
<td>No US/CT</td>
<td>No</td>
<td>Burkitt lymphoma</td>
<td>Surgery</td>
</tr>
</tbody>
</table>

M: male; F: female; UGI series: upper gastrointestinal series; CT: computed tomography; US: ultrasound; UGI endoscopy: upper gastrointestinal endoscopy
Figure 1 Duplication cyst in the antropyloric region in a 10-year-old boy. (a) Transverse US image at the level of the epigastric region shows a thick-walled cystic lesion in contact with the posterior wall of the gastric antrum. (b and c) Axial and coronal CT images of the upper abdomen show a thick-walled cystic lesion that enhances after intravenous contrast administration, in contact with the posterior wall of the pyloric antrum (asterisks).

Figure 2 Duplication cyst with ectopic pancreatic tissue in a 9-month-old girl. (a) Longitudinal and transverse US images of the epigastric region show a rounded and anechoic lesion of approximately 1.3 x 0.8 cm in the antropyloric region (asterisks). (b) Axial CT image reveals a cystic lesion in close contact with the posterior wall of the pyloric antrum (arrows). (c) Endoscopic image.
Case 3
A ten-year-old girl presented with vomiting and a history of trichophagia. An ultrasound showed an echogenic area with acoustic shadow in the epigastric region. For further evaluation, an upper GI series was performed, revealing a filling defect in the gastric chamber, which moved with extrinsic movements (these findings were consistent with bezoar). The bezoar failed to be disrupted by upper GI endoscopy and was therefore surgically removed. It turned out to be a trichobezoar measuring 19 x 5 cm (fig. 3).

Case 4
A six-year-old boy presented with alimentary vomiting an a history of use of anti-inflammatory drugs and melena of 3 months duration. The US showed increased pyloric muscle thickness (5.6 mm) and channel length (2.4 cm). The UGI

Figure 3. Trichobezoar in a 10-year-old girl. (a) Ultrasound with echogenic arc shows acoustic shadow (arrows), while (b) the upper GI series reveals a filling defect in the gastric chamber. Pictures of (c) laparoscopy and (d) surgical specimen of trichobezoar.
endoscopy showed impassable antral stenosis and dilatation was performed. The result of biopsy was chronic inactive gastritis, and therefore medical treatment was instituted.

Case 5
A five-year-old boy presented with abdominal pain in the epigastric region, anorexia and malaise of 15 days duration. The boy had a history of chronic granulomatous disease with vomiting occurring three times per day within the last week. The abdominal ultrasound showed thickening of the antropyloric wall with reduced lumen. The longitudinal diameter was 3.5 cm and thickness was 1.2 cm. An upper GI series was performed for further evaluation, showing a tubular-shaped antrum with thickened folds. Decreased antropyloric motility, with filiform passage to the duodenum. The Upper GI endoscopy showed, in turn, deformity and rigidity of the pyloric antrum, with thickened and edematous folds. Biopsy findings showed lymphocytic infiltration of the lamina propria, typical of the baseline condition. Medical treatment was initiated with fractionated diet, corticosteroids and antibiotic prophylaxis (fig. 5).

Case 6
A nine-year-old boy with a history of primary immunodeficiency (IL12 receptor B1 chain deficiency) presented with vomiting, abdominal pain and distension. An abdominal ultrasound showed thickening of the gastric wall in the antropyloric region (0.8 cm thick) and multiple enlarged retroperitoneal lymph nodes. The CT, in turn, showed multiple enlarged lymph nodes in the intercavaoortic, para-aortic and peripancreatic regions, as well as in the hilum of kidney, the mesentery and both inguinal regions, and thickening of the gastric wall in the antropyloric region. The UGI endoscopy revealed erythema and aphthous erosion in the antrum. Biopsies performed demonstrated chronic inactive gastritis and medical treatment was instituted (fig. 6).

Case 7
A two-year-old boy presented with vomiting, asthenia and palpable mass. The ultrasound showed a polylobulated hypoechoic lesion in the antropyloric region, extending towards the retroperitoneal space. The lesion was 6.2 x 4.8 x 7 cm in size. The abdominal CT scan confirmed the presence of a hypodense lesion between the left posterior superior border of the liver and the stomach in the topography of the lesser sac (omental bursa). Biopsy surgery was performed and the diagnosis was Burkitt lymphoma (fig. 7).

Discussion
In this case series, the first imaging method used for diagnosis was US. In 4 patients, wall thickening was noted in the antropyloric region (consistent with intrinsic etiology of the gastric wall). In 2 patients, structures causing wall compression were noted, provoking obstruction of extrinsic etiology. In one patient, a mass of intraluminal origin was detected. The stomach must be evaluated by ultrasound when the lumen is adequately distended with fluid. The body of the stomach, antrum and pyloric region are best examined with the patient in a right lateral decubitus position using the right lobe of the liver as an acoustic window. Images are obtained in longitudinal and transverse planes: the former shows the

Figure 4. Nine-year-old boy with a history of primary immunodeficiency and a diagnosis of chronic gastritis. (a) Abdominal ultrasound shows thickening of the gastric wall in the antropyloric region (arrow), while axial CT image of the upper abdomen (b) shows similar findings as ultrasound (arrows).
gastric antrum in long axis, while the latter provides a cross-
sectional view of the antropyloric region.

On the short-axis view, the gastric antrum has a target or
bull’s-eye appearance: the center is anechoic because of the
presence of fluid in the gastric lumen, the adjacent echogenic
layer is the submucosa and the outer hyperechoic rim is the
muscularis propria. On the long-axis view, the antrum is a tubu-
lar structure. The normal wall thickness is 3 mm or less, mea-
sured from the inner border of the echogenic submucosa to
the outer border of the hyperechoic muscle layer (which should
measure 2 mm or less in diameter). Measurements of muscle
wall thickness should be obtained with the antrum distended
by fluid to avoid simulating abnormal muscle thickening.

In our study, 3 patients underwent an upper GI series that
made it possible to assess the degree of gastric emptying,
while in 4 patients a CT with oral and intravenous contrast
enhancement was performed, which confirmed ultrasound
findings, providing a better anatomic definition of the disease.
The upper GI endoscopy, performed in 5 patients, was useful
for the assessment of lesions described in previous scans, col-
lection of biopsy specimens and/or treatment (table 1).

Below, we will briefly describe some of the pathologies found
in our study:

**Duplication cyst**

Duplication cysts are rare congenital anomalies located with-
in or adjacent to the gastrointestinal tract. Histologically, they
contain smooth muscle within their walls and are lined by
mucosa. Grossly, they are spherical cysts (80%) or tubular
structures (20%), located in or adjacent to the gastrointesti-
nal tract (frequently on the mesenteric border). They share a
common muscular wall and blood supply, having a separate
mucosa. Their most common location is the ileon, followed
by the esophagus, colon, jejunum, stomach and duodenum.
Cystic masses do not communicate with the lumen, while the
tubular varieties, most often found in the small bowel and
colon, do. Colonic duplications may communicate with sites
outside the gastrointestinal tract.

Gastric duplications cysts are rare (4-7%). They usually pres-
ent before 1 year of age with symptoms of obstruction, pain,
bleeding or ulceration, and are twice as common in girls.
Most frequently, they are located along the greater curva-
ture and do not communicate with the stomach lumen. Ectopic
pancreatic tissue and gastric mucosa are common
findings within gastric duplications.

**Bezoars**

The word bezoar is derived from the Persian pādzahr, mean-
ing “antidote”. In old times, bezoars (stones that may be
found in the guts of different animals, such as ungulates or
simians) were thought to neutralize poison. At present, a gas-
tric bezoar is a conglomeration of material within the stomach that is not readily digested. When its size limits the normal passage of gastric contents, it causes outlet obstruction. Bezoars can be composed of a variety of materials including: hair (trichobezoars), medications (pharmacobezoars, though rare in children), inspissated milk (lactobezoars, in infants receiving formula milk) and vegetable material (phytobezoars). Trichobezoars are usually seen in girls with trichotillomania and trichophagia. Rapunzel syndrome is a trichobezoar with a tail extending from the stomach to the small bowel, and it very often occurs in young women with mental disorders and trichophagia.

The imaging characteristics of bezoars vary based on the type of material present. However, bezoars can be diagnosed by almost every imaging modality. Specifically ultrasound shows an echogenic arc with acoustic shadow. Endoscopic disruption and removal of the mass may be enough treatment, but many patients require surgical removal.

Gastritis and ulcer disease
Infection with Helicobacter pylori is the most common cause of gastritis in children. Symptoms are abdominal pain, nausea and vomiting, and sonographic findings include antral wall thickening, echogenic gastric mucosa, delayed gastric emptying and an ulcer crater. Ultrasound may also be used for therapeutic follow-up.

Chronic granulomatous disease
Chronic granulomatous disease is a rare inherited primary immunodeficiency disorder. The exact etiology of this disease is unclear, but it is thought to be inflammatory, not infectious. In this disease, there is a defect in the bactericidal and fungicidal activity of phagocytes, which results in recurrent infections, inflammation and granuloma formation. Symptoms appear within the first year of life. The most commonly affected sites are the lungs, skin, gastrointestinal tract and the lymph nodes; hematogenous seeding can lead to liver abscesses and osteomyelitis. Prognosis is uncertain and a multifaceted therapeutic approach is required, comprising prophylactic antibiotics, treatment of infections, percutaneous drainage and interferon therapy.

Narrowing of the antrum with obstruction of gastric emptying occurs in 16% of patients. Histologically, there is granuloma formation and infiltration of lipid-laden histiocytes involving the lamina propria, submucosa, smooth muscle, and serosa. No organisms are usually isolated.

Conservative medical management with nutritional support, corticosteroids and antibiotics is the treatment used for this disease, with good response in a few weeks.

Lymphoma
Primary malignant tumors of the stomach are very rare in children. Specifically, lymphomas account for 1-7% of all malignant neoplasms of the stomach, although their incidence is increasing and the stomach has become the most common site of primary extranodal lymphoma. This increase is due to the well recognized role of Helicobacter pylori in the development of gastric lymphoma. Although normally there is no lymphoid tissue in the gastric mucosa, chronic Helicobacter pylori infection is associated with the development of lymphoid tissue in the lamina propria. Most primary gastric lymphomas arise from this mucosa-associated lymphoid tissue (MALT) and are therefore classified as low-grade.
grade and high-grade MALT lymphomas. While low-grade lymphomas are sensitive to antibiotic therapy, high-grade lymphomas do not respond to eradication of Helicobacter pylori and may require total tumor resection, and postoperative chemotherapy and/or radiotherapy\(^2,14\).

Burkitt lymphoma is the most frequent subtype of non-Hodgkin’s lymphoma in childhood. Gastric involvement is rare and it usually occurs as diffuse infiltration of the gastric wall or, less frequently, as a focal gastric wall mass\(^15\).

In conclusion, we consider that pediatric patients with symptoms of potential involvement of the upper gastrointestinal tract should undergo an ultrasound scan as a first approach to diagnosis. The US scan should thoroughly examine the antropyloric wall, gastric contents and extrinsic structures that pruduce gastric wall compression.

**Conflicts of interest**
The authors declare no conflicts of interest.

**References**