

# **Vomiting in children: The good coordination between radiologists and pediatricians is the key to success**

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## **Learning objectives**

- To know the most common pediatric pathologies which include vomiting as a symptom.
- To establish the indications for radiological tests and the technique of choice depending on the suspected pathology.

## **Background**

Vomiting is one of the most common symptoms in childhood. Vomiting is the act of ejecting part or all of the contents of the stomach through the mouth, usually in a series of involuntary spasmic movements. The differential diagnosis of vomiting includes gastrointestinal diseases (obstructive and inflammatory), alterations of the central nervous system (intracranial hypertension), pulmonary diseases, renal diseases, metabolic alterations, drug abuse, psychiatric disorders, pregnancy or stress.

## **Findings and procedure details**

In this study, we have reviewed the most common pathologies that can induce vomiting in different age groups, and we provide guidelines on how to approach an imaging diagnosis depending on the clinical suspicion.

The American College of Radiology (ACR) Appropriateness Criteria® are evidence-based guidelines to assist referring physicians and other

providers in making the most appropriate imaging or treatment decision for a specific clinical condition. By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.

According to this guideline there are 4 clinical conditions:

**1. Intermittent nonbilious vomiting since birth.**

Most common cause of vomiting is the regurgitation or gastroesophageal reflux. Sometimes it is difficult to differentiate from the “true vomiting”. The regurgitation is normal in the first 3 months of life and it resolves in time. These patients do not require an imaging evaluation if they maintain normal weight. In some cases a pH monitoring test may be useful to diagnosis this entity. If there are airways symptoms or bloody or bilious emesis we have to consider performing an imaging technique.

Other causes of intermittent vomiting since birth include overfeeding, pylorospasm and milk allergy. An x-ray upper gastrointestinal series may appropriate in certain circumstances according to ACR Appropriateness Criteria.

Radiologic Procedure	Rating	Comment
X-ray upper GI series	6	
US abdomen	4	It may provide useful information about gastroesophageal reflux in select patients if other testing proves unrevealing
Tc-99m sulfur colloid reflux scintigraphy	3	It may provide useful information about gastroesophageal reflux in select patients if other testing proves unrevealing
X-ray abdomen	1	It may provide useful information about gastroesophageal reflux in select patients if other testing proves unrevealing

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

## 2. **Bilious Vomiting in neonate up to 1 week old.**

Bilious emesis in a newborn is an emergency which should be evaluated with an upper gastrointestinal examination to exclude bowel malrotation and volvulus. Although abdominal radiograph may be the initial technique to approach the diagnosis, in most cases a contrast upper gastrointestinal series is considered the gold standard technique for the study of malrotations. The abdominal radiograph is commonly nonspecific; it may be normal, shows a proximal bowel obstruction or shows dilatation of multiple bowel loops. Patients should have a nasogastric tube placed to confirm the bilious emesis as well as facilitating the upper gastrointestinal exam. This exam can demonstrate an abnormal course of the duodenum that fails to cross the midline combined with a circular duodenal configuration.

Radiologic procedure	Rating	Comments
X-ray abdomen	9	Initial x-ray will help determine further workup strategy
X-ray upper GI series	8	
X-ray contrast enema	7	

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

## 3. **New onset projectile nonbilious vomiting.**

Other common cause of early infantile vomiting is the hypertrophic pyloric stenosis. It refers to idiopathic thickening of gastric pyloric musculature which then results in progressive gastric outlet obstruction. It typically occurs between 3 and 12 weeks of life. The clinical presentation is typically with non-bilious projectile vomiting in the second month of life. On physical exam these patients may have a palpable olive sized mass in the right upper quadrant. It is suggested that palpation of an "olive" with the appropriate clinical symptoms is diagnostic and that such infants do not need confirmatory imaging studies. The ultrasound is the diagnostic study of choice due to its high sensitivity and specificity and its lack of radiation. Its main disadvantage is the inability to exclude other diagnosis such as volvulus. The diagnosis criteria for the hypertrophic pyloric stenosis are:

- Pyloric muscle thickness > 3mm
- Elongated pyloric channel >18mm
- Mucosal hypertrophy
- Absence of fluid or gas in the pyloric channel during the ultrasound study.

Other common conditions producing acute vomiting at 6 weeks of age are viral gastroenteritis or pylorospasm.

Radiologic procedure	Rating	Comment
Us abdomen	9	
X-ray upper GI series	6	
X-ray abdomen	2	
Tc-99m sulfur colloid reflux scintigraphy	1	

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

#### 4. **Bilious vomiting in infant older than 3 months of life**

Intussusception is the most common cause of intestinal obstruction in children aged 3 to 36 months. It occurs when one segment of bowel is pulled into itself by peristalsis. Most cases are idiopathic and they are related with gastroenteritis, possibly due to hypertrophy of lymphoid tissue in the terminal ileum.

In infants a pathologic lead point is more frequently identified such as Meckel's diverticulum, enteric duplication cyst, lymphoma, polyps or intramural hemorrhage. The clinical presentation includes intermittent abdominal pain, vomiting and right upper quadrant mass with drawing-up of legs and inconsolable crying. They may have gross blood on rectal examination. The ileocolic region is the most common due to the abundance of lymphoid tissue. The diagnostic techniques include abdominal radiograph and ultrasound. Abdominal radiograph may demonstrate an elongated soft tissue mass in the right upper quadrant with a bowel obstruction proximal to it. Classically the gold standard technique for the diagnosis and treatment is the contrast enema; however ultrasounds have a high specificity nowadays. Ultrasounds signs include the target and the pseudokidney sign. Also the intussusception can be reduced with a water soluble medium guided

by ultrasounds. The contraindications to enema reduction are the presence of pneumoperitoneum, clinical peritonitis or an unstable patient. Incidental small bowel-small bowel intussusception which may be seen on US or CT is typically transient and asymptomatic.

We must consider other bowel obstructions less common, such as meconium ileus, Hirschsprung's disease or ileal atresia, in which upper gastrointestinal imaging can help in the diagnosis.

Meconium ileus refers to a newborn bowel obstruction of the distal ileum due to abnormally thick impacted meconium. Meconium is normally evacuated within 6 hours of birth or earlier. Meconium ileus occurs when it becomes inspissated and obstructs the distal small bowel. It is usually the earliest clinical manifestation of cystic fibrosis. The abdominal radiograph may show dilated bowel loops without air-fluid levels. The contrast enema study shows a microcolon with multiple small filling defects in the right colon or in the distal ileum representing meconium concretions.

Hirschsprung disease is caused by an absence of ganglion cells in the distal colon and rectum due to a failure of neuroblasts migration to the distal bowel before the 12<sup>th</sup> week of gestational age. The segment of aganglionosis is typically continuous and most commonly involves the rectum and a portion of the sigmoid colon. Abdominal radiographs show the typical findings of a bowel obstruction. A contrast enema study is required for the diagnosis of Hirschsprung disease and also for assessment the length of involvement. Characteristic radiologic findings include an abnormal rectosigmoid ratio, transition zone of rectal narrowing, irregular rectal contractions and retained contrast material on delayed radiographs.

Ileal atresia is a congenital abnormality where there is significant stenosis or complete absence of a portion of ileum. The cause is thought to be related to an intrauterine ischemic insult. Abdominal radiography usually shows dilated loops of proximal bowel. Bariums studies will confirm the level of obstruction showing a termination of the contrast-filled loops in the ileum.

In older children, other causes such as appendicitis, incarcerated hernias, peritoneal adhesions or Meckel's diverticulum must also be considered.

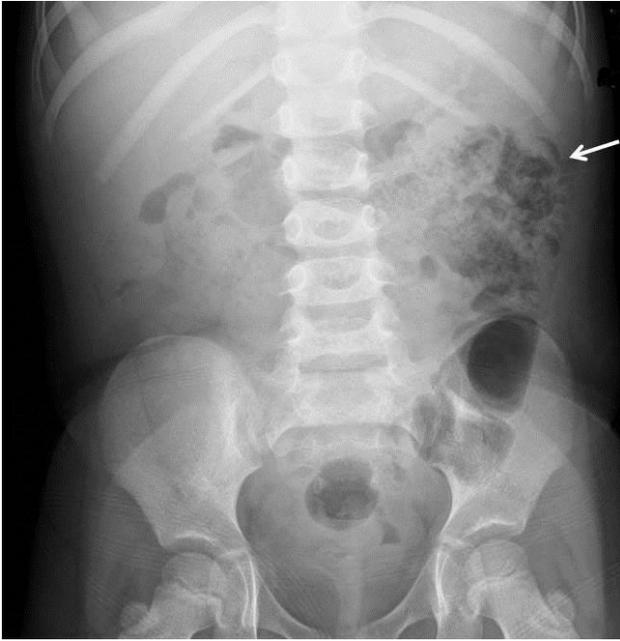
The less common causes outside the gastrointestinal tract include: alterations of the central nervous system (intracranial hypertension), pulmonary diseases, renal diseases, metabolic alterations, drug abuse, psychiatric disorders, pregnancy or stress.

## **Conclusion**

Vomiting in children can cause a diagnostic challenge. Coordination between radiologist and pediatrician is essential, as well as the knowledge of the different causes of vomiting depending on the age group and the imaging technique of choice, in order to reach a diagnosis

## **References**

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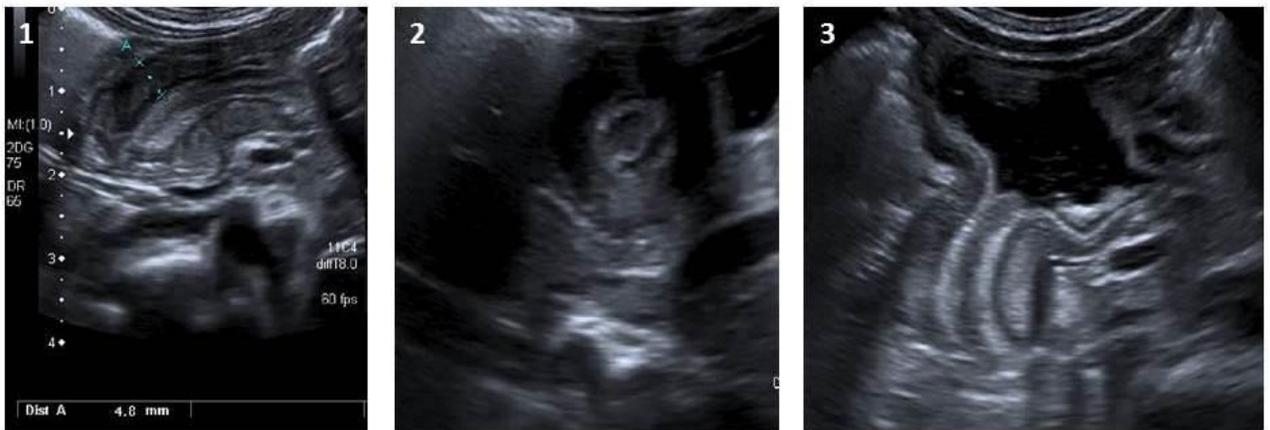
**Fig. 1:** Intestinal malrotation: 1. Abdominal x-ray of a patient with history of bilious vomiting. Colon is positioned abnormally, the cecum is located in left upper quadrant of abdomen (white arrow).



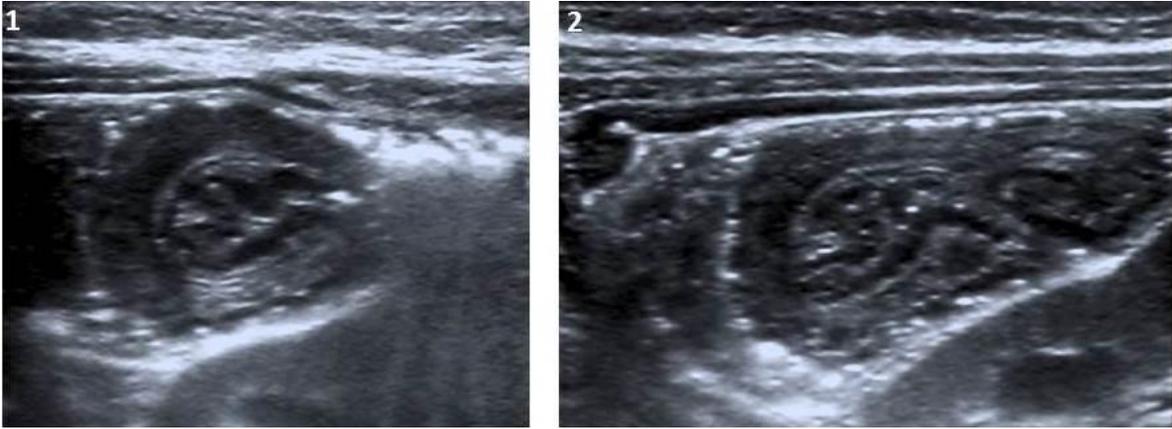
**Fig. 2:** Intestinal malrotation: 2. Barium enema of a patient with history of bilious vomiting. Colon is positioned abnormally, the cecum is located in left upper quadrant of abdomen (white arrow). 3. Gastroduodenal barium study. Cecum in left upper quadrant of abdomen (red arrow) pushes the small bowel loops into the right.



**Fig. 3:** Intestinal malrotation: 4. Axial contrast-enhanced CT shows inverted relationship between superior mesenteric vein and artery (red arrow).



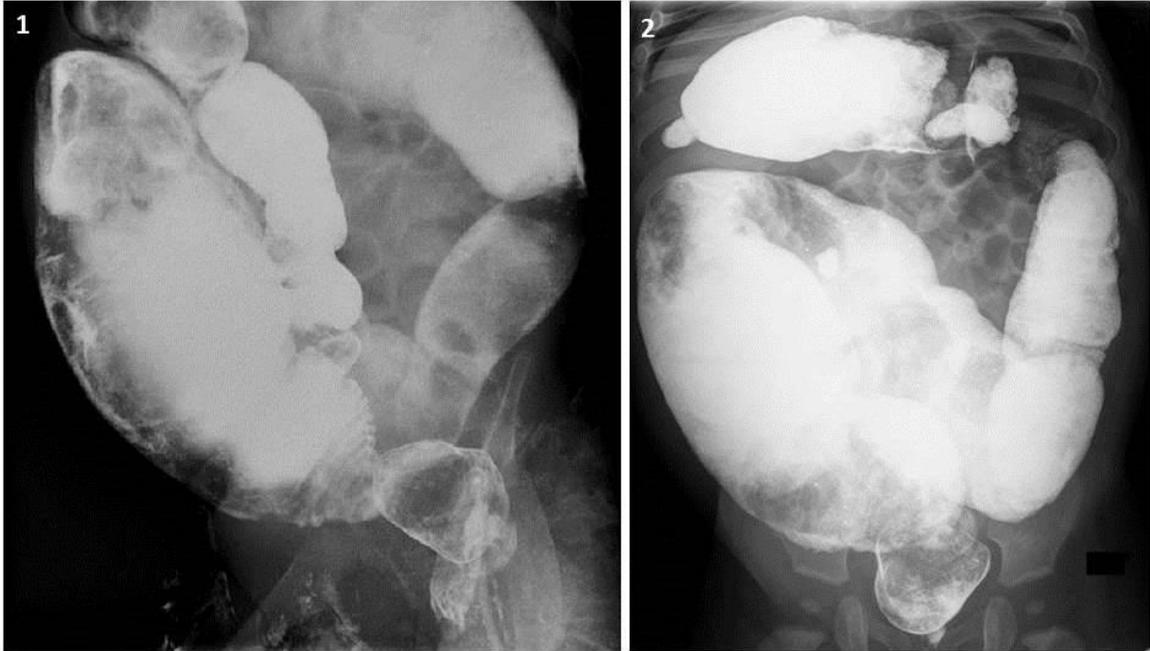
**Fig. 4:** Longitudinal (1,3) and transverse (2) ultrasonographic images of the pylorus in a patient with surgically proven hypertrophic pyloric stenosis



**Fig. 5:** Transverse and longitudinal ultrasonographic images show an ileocecal intussusception in the right upper abdomen of a 2 year old patient.



**Fig. 6:** Supine abdominal radiograph in a patient with Hirschsprung's disease demonstrates megacolon and transition zone.



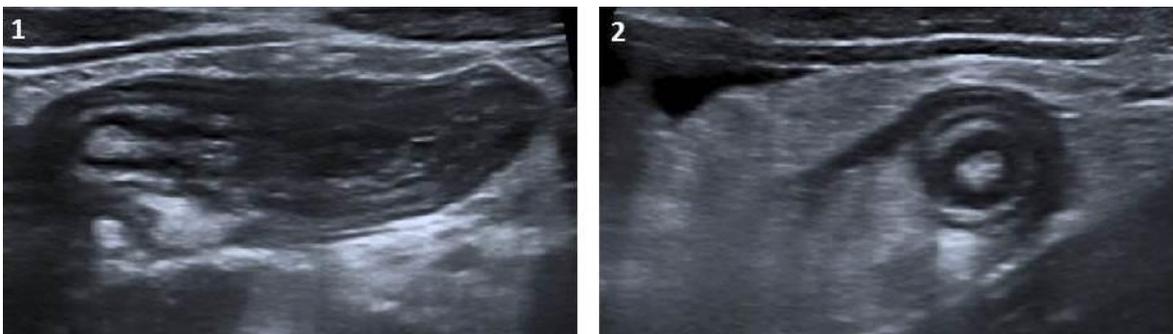
**Fig. 7:** Hirschsprung's disease: Contrast enema shows abnormal rectosigmoid index and transition zone with narrow caliber of the rectum and dilated proximal sigmoid colon. The rectum/sigmoid ratio is 0,5.



**Fig. 8:** Small bowel atresia: Abdominal x-ray shows distention of proximal bowel without dilation of distal loops in a patient with small bowel atresia.



**Fig. 9:** Gastroduodenal barium study in a patient with duodenal stenosis. It shows the lack of passage of contrast material through the duodenum.



**Fig. 10:** Acute appendicitis with target sign. Longitudinal and transverse US images (1 and 2) through an inflamed appendix with a “target” appearance.