Learning objectives

• Review the clinical manifestations and classification of gastroesophageal reflux (GER) in children.
• Review the methodology of ultrasonography in the evaluation of gastroesophageal reflux and describe the main sonographic features.
**Background**

- Regurgitation, or gastroesophageal reflux (GER), is normal in the first 3 months of life and resolves in time. It usually has no definitive pathologic cause and, is unrelated to a functional defect. Rarely, regurgitation may be due to displacement of a portion of the stomach into the chest, (ie, hiatal hernia). In other cases, low esophageal sphincter pressures or delays in gastric emptying have been implicated as causative and typically resolve in time.
- Gastroesophageal reflux has been shown to be directly related to disease, such as esophagitis, asthma, recurrent pneumonia and reduced pulmonary function, apnea, and sudden infant death syndrome.
- The association between gastric emptying and gastro-esophageal reflux (GER) has been widely recognised from scintigraphic studies.
- Sonography has been described as an informative, sensitive, and accurate method, providing morphologic and functional information in this disease.
- The advantages of ultrasound are: easy to perform, excellent for gastric outlet evaluation and no ionizing radiation.
- Intraabdominal esophagus is one of the main elements of the gastroesophageal junction, and its length constitutes an important diagnostic indicator in children with GER.

**Classification of gastro-esophageal reflux in children:**

- **Pathological reflux:** Great volume and frequency. It may or may not be associated with other injuries
- **Physiological reflux:** Due to the immaturity of the antireflux barrier, appears between birth and 4 months, tending to disappear with idade. Restaura the pH after the episode quickly
- **Hidden Reflux:** Found during the evaluation of nasal or respiratory conditions
- **Reflux Primary:** due to dysfunction of the antireflux barrier
- **Reflux Secondary:** As a consequence of other diseases (annular pancreas, duodenal ring, inborn errors of metabolism, chronic renal failure, intracranial hypertension).

**Clinical manifestations of gastroesophageal reflux:**

- Symptoms due to regurgitation and its consequences (vomiting and malnutrition)
- Symptoms due to esophagitis and its consequences (pain, irritation, anemia, stenosis, haematemesis)
- Respiratory symptoms (pneumonia, stridor, coughing)
• Neurobehavioral symptoms

• Parental complaints of vomiting or regurgitation in neonates during the first 3 months of life are common. The cause is usually GER, particularly in the first weeks of life and with overfeeding.
• Other than GER, common causes of vomiting in the first 6 weeks of life include neonatal sepsis, hypertrophic pyloric stenosis (HPS), n pylorospasm. It can occur with necrotizing enterocolitis in premature infants.
• Less common causes exist, with the most important one being the clinically emergent problem of bowel malrotation with midgut volvulus

These are the 4 scenarios that were used for the American College of Radiology (ACR) Appropriateness Criteria for Vomiting in Infants up to 3 Months of Age: Biliary vomiting in neonate up to 1 week old, Biliary vomiting in infant 1 week to 3 months old, Intermittent nonbiliary vomiting since birth, New onset projectile nonbiliary vomiting. However, they still consider the role of US for assessing reflux is less well established.

• Many authors have pointed out that ultrasound with water used as a contrast agent, can be highly successful in imaging gastric emptying.
• US can provide functional as well as morphologic information.
• US has the advantage over UGI series in that it does not use ionizing radiation.
• The major difficulties for some radiologists with regard to the use of US are that its success depends on the skill of the operator
Imaging findings OR Procedure details

• A review of 500 ultrasound examinations performed in children for investigation of gastroesophageal reflux, which were examined in the Imaging Center at the Hospital Clinicas de Niterói (HCN), Rio de Janeiro, Brazil.

How do ultrasound to search for gastroesophageal reflux?

• Place the child in the supine position and examine the entire abdomen.
• After the usual feeding, place the probe in longitudinal, slightly left of the midline of the abdomen.
• By identifying the cardia, if the transducer angled slightly, we see the distal esophagus (FIG. 1).
• We measure the opening of the cardia (FIG. 2)
• Find measure the opening of the cardia and see if there is flow of "bright echoes". (FIG. 3).
• Remember the events of the gastro-esophageal reflux: Lower esophageal esfincer opening; movement of gastric contents into the distal esophagus (ascent and descent), cleaning of the esophagus by peristalsis and closure closure of lower esophageal sphincter.
• Duration about 10 minutes.
• It was "positive" for gastro-esophageal reflux when after the opening of the cardia was seen rising into the esophagus terminal a liquid column (FIG 4).

• Among the 500 patients examined by ultrasound to search for gastroesophageal reflux, 418 had tested positive and 82 negative (FIG 5).
• There were 47 boys and 35 girls without reflux during the examination.
• It was very small the difference in the occurrence of reflux between the sexes (55 % boys and 45% girls) (FIG 6).

• In all cases the measurement was made of the cardia opening during gastroesophageal reflux and also measured the intra-abdominal esophagus (FIG 7).
• As the opening of the cardia was observed in this study over the range 7.1 to 9.0 mm, disagreeing with the literature, which presented values between 10 to 14mm, and 4.2 to20 mmintervals described as the most frequent.

• There was a decrease in numbers of patients as they had an increase in age, which speaks in favor of the maturation of the antireflux barrier (FIG 8).
• Classification of the severity of gastro-esophageal reflux is evident in the ultrasound examinations: predominated moderate reflux (3-5 episodes in 10 min) in 234 exams (FIGs 9, 10).

• We observed mild gastroesophageal reflux, characterized by the presence of 1 or 2 episodes in 10 minutes of examination, in 157 patients (FIG 11).

• Severe gastroesophageal reflux (more than 6 episodes in 10 min) occurs in 27 exams (FIG. 12).
Fig. 1: Viewing and measuring the distal esophagus.

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Fig. 2: Measuring the cardia on transabdominal ultrasound.

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Fig. 3: Measuring the cardia on transabdominal ultrasound and viewing gastroesophageal reflux.

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Fig. 4: Viewing gastroesophageal reflux with flow of "bright echoes."

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Fig. 5: Transabdominal ultrasound assessment of 500 children with clinical symptoms of gastroesophageal reflux.

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Fig. 6: Occurrence of gastroesophageal reflux demonstrated by ultrasonography in relation to sex.

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Fig. 7: Several cases with gastroesophageal reflux, showing the measurements.

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Fig. 8: Age of patients X gastroesophageal reflux in ultrasonography.

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Fig. 9: Classification of the severity of gastroesophageal reflux is evident in the ultrasound examinations.

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Fig. 10: Boy. 5 months old. Moderate gastroesophageal reflux: 4 episodes within 10 minutes. Intraabdominal esophagus measured 2.5 cm and cardia 1.0 cm.

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**Fig. 11:** Mild gastroesophageal reflux: an episode in a period of 10 minutes. Intraabdominal esophagus (3.0 cm) and cardia (0.6 cm).

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Fig. 12: Boy. 5 months old. Moderate gastroesophageal reflux: 3 episodes within 10 minutes. Intraabdominal esophagus measured 2,1 cm and cardia 1,7 cm.

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Conclusion

Ultrasound is an effective method in the investigation of gastroesophageal reflux disease in children, and easy to perform with high sensitivity.

- Sonographic diagnosis of GERD is based mainly on the visualization of the passage of gastric fluid into the abdominal esophagus and the esophageal clearance of refluxed material by peristalsis.
- The occurrence of gastro-esophageal reflux occurred in both sexes, with a slight predominance in males.
- The measuring range of the more frequent opening of the cardia in the investigation of GERD was 0.71 to 0.90 cm.
- Classification of the severity of gastro-esophageal reflux is evident in the ultrasound examinations: predominated moderate reflux. 3 was the number of episodes most often seen.
- The most affected age group was 6 days to 5 months and 29 days.
- The number of patients decreases as age increases, which probably is due to the maturation of the antireflux barrier.
- Ultrasound is an effective method in the investigation of gastro-esophageal reflux, easy to perform, with a sensitivity very similar to that described by literature and also taking the advantage of not using ionizing radiation, which is very important, considering the age of the patients evaluated.
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