Gastroesophageal reflux: radiological aspects

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Abstract. Numerous recent diagnostic methods have made gastro-esophageal reflux (GER) a significant challenge for the clinician. We report our experience with radiologic studies in 1188 children, 352 of whom also underwent esophageal manometry. Radiologic examination is the least sensitive method of demonstrating reflux, but has the advantage of detecting anatomic malformations and upper gastrointestinal obstruction. The success rate is more than doubled when the water siphon test is also used. The X-ray signs and classification of reflux are described. Reflux scintigraphy is a very sensitive and highly specific technique that is especially suitable when pulmonary lesions are suspected or for follow-up after therapy. Another noninvasive procedure involving no radiation exposure is ultrasonography. The results of various concurrent methods, including esophageal manometry and pH determinations, are compared. The association of reflux with pyloric stenosis, brachyesophagus, peptic esophageal stenosis, and 13 other disorders is discussed and a plea made for drastic reduction of the use of X-ray studies in GER. The indication for using mechanical devices must be made subjectively in each individual case depending upon the clinical symptoms, the equipment available, and the experience of the physician.

Key words: Reflux, gastroesophageal — Cardiac incompetence — Chalasia of cardia — Imaging methods — Esophagus, shortened, peptic stenosis of

Introduction

Gastroesophageal reflux (GER) is a problem which has occupied pediatricians [12, 59], pediatric radiologists [37, 47, 66, 74], and pediatric surgeons [7, 41] for decades, the latter in particular due to the consequences of treatment. Reflux is found in more than one-half of cases of vomiting in infants, is more common in males than females (2,7 : 1), and is a frequent cause of morbidity and mortality. The various clinical forms of reflux, from “spitting up” or regurgitation of massive or projectile vomiting, require individualized evaluation from which the appropriate therapy is determined. Numerous disorders have recently been found to be associated with reflux or to have a causal relationship.

Newer diagnostic methods (pH studies, esophageal manometry, endoscopy) and, in particular, imaging methods such as reflux scintigraphy, the water siphon test, and ultrasonography have provided incentives for precision in the diagnosis of reflux. We have studied 653 children at the Children’s Hospital and Department of Pediatric Surgery in Bremen and 535 at the Children’s Hospital of the University of Heidelberg from 1957–1984 [73, 74] in whom GER was confirmed radiographically.

Clinical prerequisites and indications for imaging techniques

Knowledge of the clinical data is important for the radiologist in order to set the indications for and choice of examination and their sequence. The history, e.g. vomiting since birth, plays as significant role in distinguishing hiatal hernia
from pyloric stenosis. Age must be taken into consideration: the common and usually harmless reflux seen during the first 6–8 weeks of life does not warrant radiologic studies, as it should generally be regarded as physiological. The type of vomiting gives valuable information: regurgitation and occasional "spitting up" are harmless symptoms which soon disappear. Acidic vomitus arises in the stomach, non-acidic material from the esophagus, and bile points to postpapillary duodenal obstruction.

The time relationship of vomiting to meals aids in differentiating obstruction at various levels of the upper gastrointestinal (GI) tract. The amount vomited is of importance, as major nutritional losses lead to failure to thrive and atrophy, water loss, and electrolyte imbalance. Finally, the appearance of the vomitus should be noted: hemorrhagic gastritis due to pyloric stenosis may produce bloody admixture, while hematemesis is a grave symptom pointing to reflux esophagitis. Blood counts and stool examinations for occult blood are important since iron deficiency anemia may be the only sign of a reflux esophagitis [10].

Consideration of the above points allows the following three questions to be answered:
1. Is the vomiting harmless or serious?
2. Do the clinical symptoms strongly point to reflux, or may they also be present without reflux?
3. Are diagnostic procedures indicated, and if so, is a radiologic study justified or is a less invasive method preferable?

The following should be regarded as indications for X-ray studies: (1) insufficient weight gain or failure to thrive; (2) recurrent aspiration and bronchopneumonia; (3) iron deficiency anemia; (4) dysphagia; (5) hematemesis; (6) frequent and severe vomiting; and (7) melena.

**Imaging methods**

**Radiologic examination**

Radiologic studies have changed enormously during the last few decades due to refinement and standardization of the technique, with a reduction in radiation dosage. The advent of the image intensifier and the transition from conventional films to rapid-series photofluoro graphic spot films have enhanced diagnostic precision; modern devices (Infantoskop, Pediatrix) which place the child in any desired position with automatic fixation have minimized stress for the child and simplified the task of the physician. Fluoroscopy times are brief; the entire examination is easy to perform and noninvasive.

The X-ray technique has been published by Ebel and Willich [24] as well as many others [38, 58]. Reflux must be tested in both upright and recumbent positions, with supine and oblique views. The Trendelenburg position with full stomach is only productive in the presence of a flaccid cardia and spontaneous reflux. Manual compression of the epigastrum may provoke reflux in some cases, but may also reveal an otherwise reduced hiatus hernia [72].

If X-ray findings are negative, the water siphon test [9, 27]—also known as Carvalho's test—should be performed. During swallowing, pressure decreases in the lower esophagus; GER is most easily induced in this phase. The stomach is filled with contrast material, which reflexes when water or tea is given. This test may be regarded as a practical screening method: the radiation dose is reduced, since no long-term fluoroscopic observation for GER is necessary.

Barium sulfate suspension is normally used; water soluble contrast material is indicated only in cases of suspected perforation. The surface dose of radiation for the entire study is 6,8 mGy (= 680 mrad) [44]. The specificity without maneuvers is 30%–50% for primary reflux, the sensitivity 85% [4, 13, 33, 63].

The radiologic signs of GER are manifold. Reflux may be inferred from the plain chest film alone in many cases from the dilated, air-filled esophagus, also known as pneumoesophagus [19, 20] or mega-aeresophagus [68] (Fig. 1). A gasless abdomen should also lead to the consideration of GER in addition to the numerous other causes [25]. The pulmonary lesions often produced by chronic reflux (aspiration, recurrent bronchopneumonia) are discussed in a later section.

The position of the cardia is best discernible after several barium swallows. In newborns, it lies at the level of the diaphragm or slightly below it (Fig. 2 a); tremendous physiological respiratory variations are seen ("cardia mobilis", Figs. 2 d, 3). Its width is also of note: there may be enormous differences in caliber under normal conditions. Persistent widening of the lower esophagus as well after the newborn period (chalasia, lax esophagus) indicates a disorder of cardiac closure.

The lower esophagus (abdominal esophagus, esophagogastric junction), designated the "lower esophageal sphincter" in the American literature although it does not meet the anatomical criteria of a sphincter muscle, deserves special attention. The intra-abdominal portion of the esophagus is