Imaging of the upper gastrointestinal tract: endoscopy or radiology?

Introduction

Diseases of the upper gastrointestinal system are very common in the modern word with an increasing frequency over recent years. Clinical symptoms are rather non-specific and may be the result of simple gastro-oesophageal reflux or an advanced malignant process.

Historically, the investigation of upper gastrointestinal complaints was based on plain radiography and contrast studies. Now, a flexible oesophagogastroduodenoscopy has become the primary imaging modality in patients with upper gastrointestinal symptoms. Dynamic contrast studies and cross-sectional imaging remain the main diagnostic tests in certain pathological conditions and provide an additional and complementary information to endoscopy results.

This article presents a comprehensive review of imaging techniques available in the radiology department, and discusses the strengths and limitation of these techniques, compared with endoscopy, to delineate the best diagnostic pathway and optimum choice for patients.

Background

The upper gastrointestinal tract comprises the pharynx, the oesophagus, the stomach and duodenum. These organs are associated with specific pathologies which cause a variety of symptoms. The most common complaints include: dyspepsia, indigestion, dysphagia, heartburn, nausea and vomiting, or less specifically upper abdominal pain or weight loss.

Plain radiography

Plain X-ray of the chest and upper abdomen is no longer commonly used in the investigation of upper gastrointestinal complaints.

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The oesophagus, which is located in the posterior mediastinum, has a very similar density to other soft tissue structures and is not clearly identifiable on the chest radiograph. Only significant dilatation of the oesophagus, filled with air or fluid, may be visible on X-rays in patients with long-standing problems, such as stricture or achalasia.

X-ray can be useful in diagnosis of gastric or duodenal obstruction or localization of swallowed foreign bodies. It is also performed as an initial examination when perforation is suspected. Hiatus hernia is a common incidental finding on chest X-rays in elderly patients and is clearly visible as a well-defined air-filled structure, projecting behind the heart (*Figure 1*).

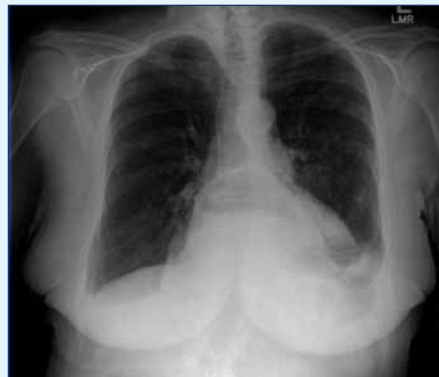
Contrast study

Oesophagus

A contrast study is the most common radiological examination in evaluation of oesophageal disease. Oesophagography can be performed as a single contrast or double contrast technique.

Single contrast examination is used to evaluate the patency of the oesophagus, strictures, extrinsic abnormalities or motility disorders with very poor demonstration of mucosal details (*Figure 2*). Images of the oesophagus are obtained in the upright position, when the patient drinks medium-density barium.

Figure 1. Chest radiograph showing a dilated oesophagus and large hiatus hernia. The stomach with an air–fluid level is projecting behind the shadow of the heart.



Double contrast examination uses two contrast media (barium and air), which allows the visualization of mucosal details in the early inflammatory changes of reflux disease, infectious oesophagitis or tumour formation (*Figure 3*).

Water-soluble contrast material should be used in patients with clinical suspicion

Figure 2. Single contrast barium swallow demonstrates a diffuse mucosal irregularity in a patient with Crohn's disease of the oesophagus.

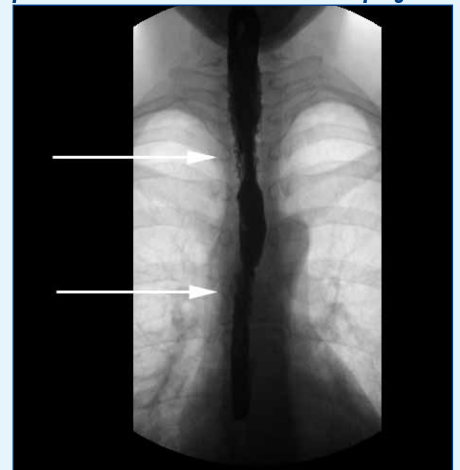
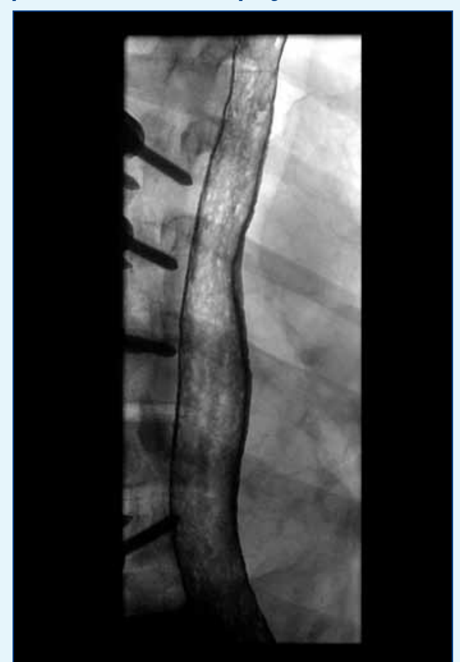


Figure 3. Double contrast barium swallow shows an advanced mucosal inflammatory changes in patient with Candida oesophagitis.



of perforation and should be avoided in situations where there is suspicion of tracheo-bronchial aspiration or tracheo-oesophageal fistula, because of the risk of developing pulmonary oedema.

Structural abnormalities

The structural abnormalities which can be seen include:

1. Oesophageal atresia with or without tracheoesophageal fistula
2. Diverticula – these are very common and usually develop at the site of weakness in the oesophageal wall: posterior pharyngeal diverticulum (Zenker's diverticulum), lateral pharyngeal pouch (in players of wind instruments or glass blowers), lateral cervical or epiphrenic diverticulum (*Figure 4*). Pseudo-diverticulosis is a very interesting condition involving dilated submucosal glands in the presence of an inflammatory or infective process, most often seen in Candida oesophagitis
3. Webs are a common incidental finding, usually in middle-aged women. They are seen in up to 8% of barium examinations and represent a thick mucosal fold, which arises from the anterior wall of the cervical oesophagus
4. Hiatus hernia: most cases (99%) are a sliding hernia while only 1% are para-oesophageal hernia
5. Congenital abnormalities of the great vessels and acquired vascular abnormalities which cause extrinsic impressions on the oesophagus.

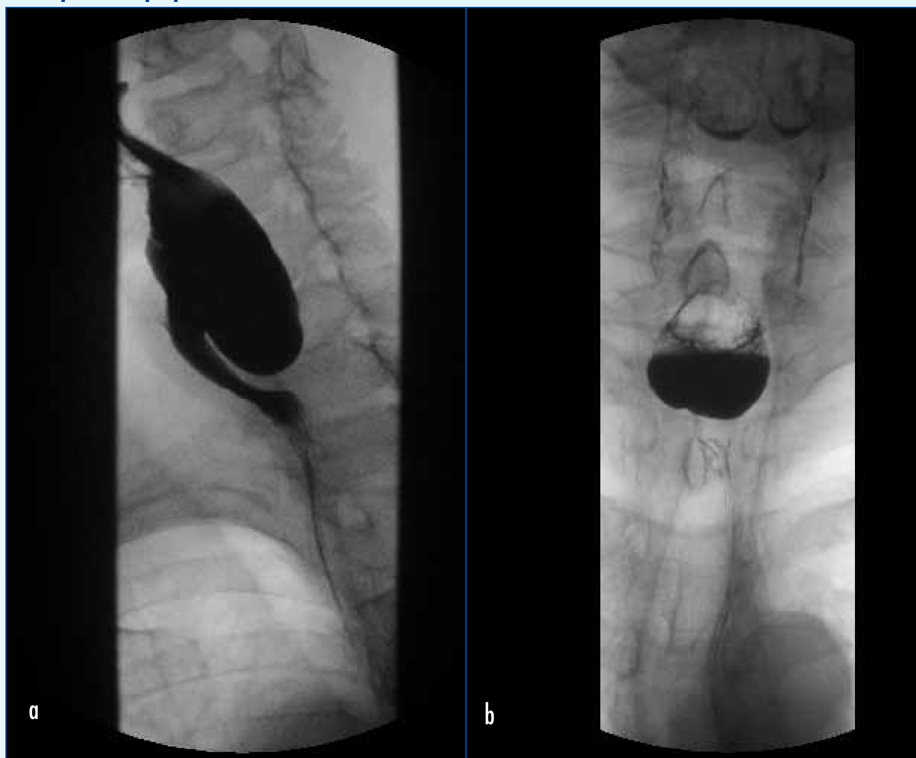
When a structural abnormality is suspected, contrast study remains the examination of choice. Focal abnormalities such as webs and small diverticula can be easily missed endoscopically, when small strictures and rings may not be visible on endoscopy.

Contrast study is also more useful in very narrow strictures, which cannot be passed with an endoscope, to evaluate the length of the abnormality and delineate internal or external components. Large diverticula and cases of advanced intramural disease have an increased risk of perforation during endoscopy.

Oesophagitis

Endoscopy is better than radiology in the diagnosis of inflammatory and infective disease of the oesophagus. Contrast studies are accurate in moderate and advanced disease, but are not sufficiently sensitive in the demonstration of mild inflammatory changes.

Figure 4. Large oesophageal diverticulum seen on the contrast examination in the (a) lateral and (b) anteroposterior projection.



Radiographic findings are directly related to the severity of pathological process and include: loss of smooth mucosal surface and its irregularity, nodular or granular pattern, thickening of mucosal folds, erosions, ulcerations and strictures. There are several characteristic features (location of pathological changes, their shape and size) on the images, which may help to differentiate between several pathological conditions as reflux oesophagitis, Barrett's oesophagus or infections caused by Candida, cytomegalovirus and *Mycobacterium tuberculosis* (*Figures 2* and *3*).

However, these patients will require endoscopy as a second-line examination to obtain a biopsy of the abnormal areas demonstrated by contrast study.

Motility disorders

Dysphagia is one of the most commonly presenting symptoms of upper gastrointestinal disorders and is often caused by functional abnormalities. Patients with dysphagia are often poor at localizing the site of the obstruction and more than half complain of symptoms high in the neck.

Endoscopy and radiology are complementary investigations, but contrast swallow remains the examination of first choice in these patients, as it allows a dynamic examination of the neuromuscular function as well as assessment of oesophageal structures.

In patients with a history of dysphagia, contrast examination should involve a dynamic assessment with videofluoroscopy of the oropharyngeal and oesophageal phase of swallowing, which allows detailed assessment of tongue movement and bolus formation, function of the palate, laryngeal elevation, closure of the epiglottis and cricopharyngeal sphincter function. Some subtle abnormalities such as webs may only be transiently visible during the passage of contrast.

The oesophageal part of the contrast swallow demonstrates the details of oesophageal motility with primary and secondary peristalsis, tertiary non-propulsive contractions, complex function of the lower oesophageal sphincter and the presence of gastro-oesophageal reflux.

Disorders of oesophageal motility can be divided into primary (achalasia, diffuse oesophageal spasm, nutcracker oesopha-

gus) and secondary (systemic sclerosis, diabetes or neurological disease: post intracranial infarction or head injuries, multiple sclerosis, poliomyelitis, Parkinson's disease).

Focal lesions

Focal abnormality within the oesophagus can be visible on the contrast examination as a constant filling defect, stricture or focal area of ulceration or mucosal irregularity (*Figure 5*).

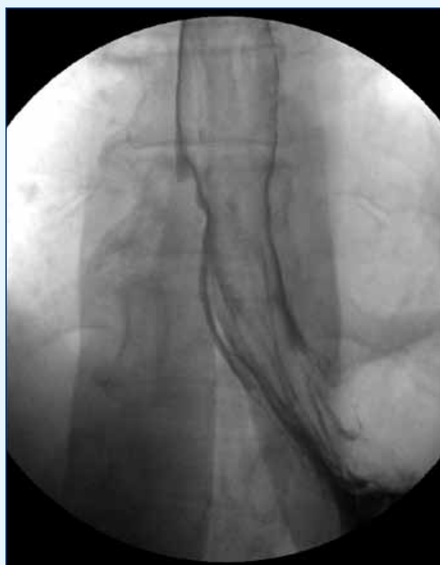
Characteristic radiographic features (shape, position and pattern of the changes) are highly suggestive of the nature of the lesion (benign or malignant) and its origin (intraluminal, intramural or extraluminal). Cardiomegaly, vascular anomalies or masses arising from the adjacent structures in the mediastinum may cause an external compression of the oesophageal lumen or its displacement.

Focal lesions in the oesophagus include:

1. Foreign bodies
2. Varices
3. Congenital duplication cysts and retention cysts
4. Benign neoplasms – leiomyoma, fibrovascular polyp, papilloma, fibroma
5. Malignant neoplasms – squamous cell carcinoma, adenocarcinoma, lymphoma.

All patients with suspicion of soft tissue mass on contrast examination will require subsequent oesophagogastroduodenoscopy and biopsy to determine the nature of the lesion.

Figure 5. Contrast swallow shows a well-defined submucosal lesion in the distal oesophagus.



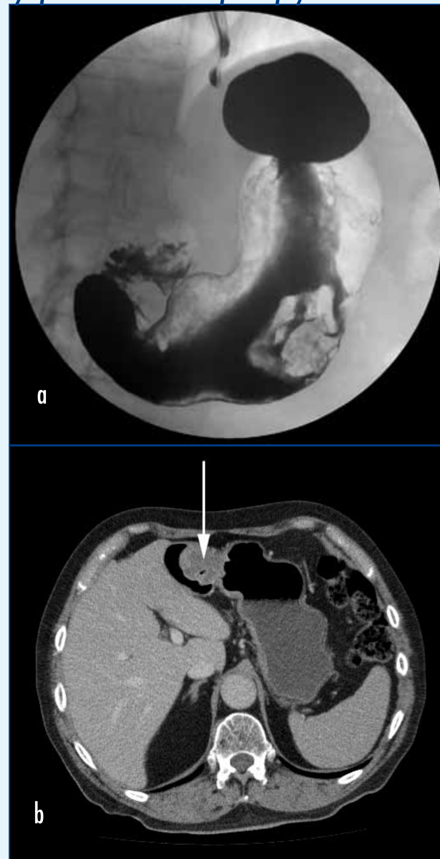
Stomach

Endoscopy is now the preferred examination over the barium meal in the investigation of gastric and duodenal pathology, as it is more sensitive in detecting mucosal lesions and offers a possibility of biopsy and soft tissue diagnosis.

Radiological features of inflammatory and neoplastic changes in gastric mucosa involve an alteration of the mucosal pattern, from very slight mucosal nodularity to large ulcerative lesions or strictures (*Figure 6*). These are similar in many different conditions and the aetiology of the pathological process cannot be fully established.

The barium meal is reserved for patients who can not tolerate endoscopy or when endoscopy is incomplete or non-conclusive. It is often performed in patients after previous gastric or oesophageal surgery with limited endoscopic access. Bariatric surgery, especially gastric banding, is another indication for contrast examination, which frequency has significantly increased over recent years. Assessment of the remaining gastric lumen and detection of possible complications (hernia or slipped band) is crucial for proper management of these patients.

Figure 6. a. Barium meal shows a large filling defect in the distal part of the stomach. b. Computed tomography abdomen confirmed a polypoid soft tissue lesion arising from the greater curvature, which was diagnosed as gastric lymphoma after endoscopic biopsy.



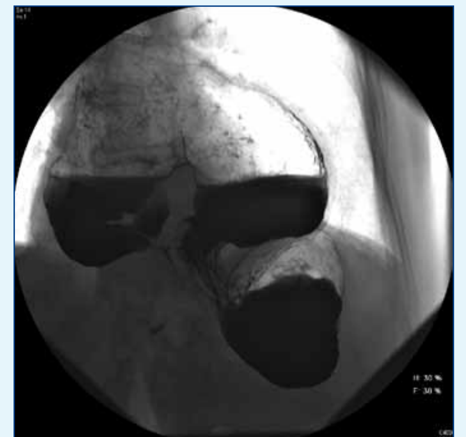
The contrast study is also superior to endoscopy in patients with structural abnormalities or functional disorders (*Figure 7*). Structural abnormalities include: hiatus hernia, volvulus, duplication cysts and diverticula. Assessment of functional problems, such as gastroparesis or gastro-oesophageal reflux, provides information about its nature, severity and extension.

Ultrasound

Ultrasonography has very limited value in the diagnosis of oesophageal and gastric pathology, because of a significant amount of intraluminal air. It is the examination of choice in neonates with suspicion of pyloric stenosis. It is performed as a dynamic examination, does not include ionizing radiation or a fasting period for the neonate and has almost completely replaced contrast examination which was used previously (*Figure 8*).

Endoscopic ultrasonography is a fairly new technique, which combines videoendoscopy and high frequency ultrasound. It shows the structure of the oesophageal and gastric wall with a differentiation of five layers, which can not be clearly identified, even on computed tomography examination. Assessment of local lymph nodes

Figure 7. Large hiatus hernia seen on the contrast study. Part of the stomach located above the diaphragm is rotated around its axis and represents a gastric volvulus.



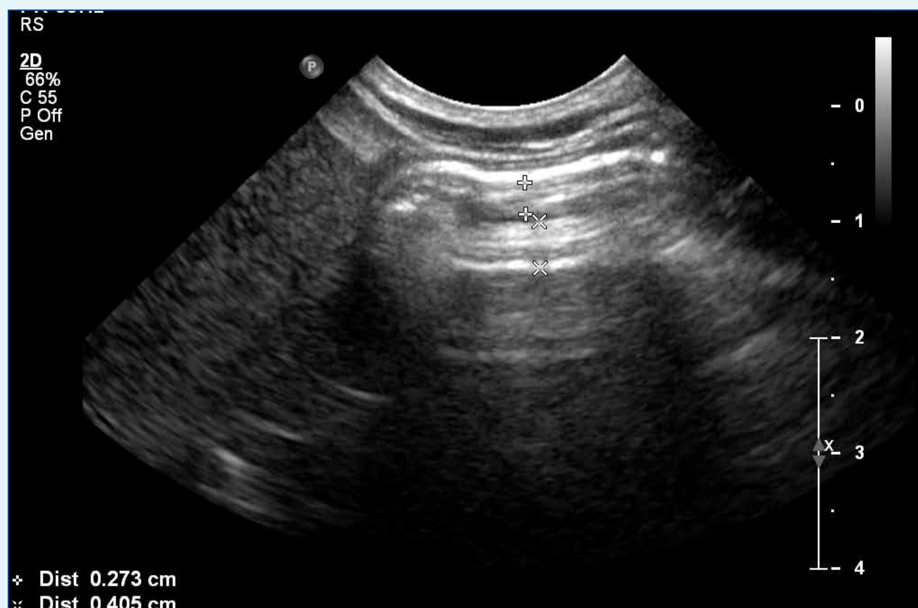


Figure 8. Ultrasound of the abdomen shows an elongated pyloric canal with diffuse wall thickening, consistent with pyloric stenosis.

includes not only the size, but shape, outline and internal structure to allow differentiation between benign and malignant processes. This examination is mainly used in the local staging of oesophageal malignancy.

Negative points of this technique include small, limited field of view and considerable size of the intraluminal probe – 13 mm (difficulties in passing the malignant tumour have been reported in up to 20% of cases).

Computed tomography

Computed tomography shows low sensitivity and specificity in the diagnosis of oesophageal disorders, mainly because of the absence of intraluminal distention. Mild or moderate wall thickening can be easily missed or interpreted as normal appearance of 'collapsed' oesophagus. However, computed tomography is the examination of choice in staging of the malignant process to assess the depth of wall penetration, invasion of adjacent structures, involvement of lymph nodes and distant metastasis (*Figure 9*). Every patient with a confirmed malignant lesion will have a staging computed tomography of the chest, abdomen and pelvis performed before any treatment decision is made.

Computed tomography is also performed in clinical situations where there are suspicions of oesophageal perforation to confirm the diagnosis and to look for mediastinal and pleural collections. In suspected gastroduodenal perforation, even a small amount of free intraperitoneal air can be demonstrated.

Computed tomography has high accuracy in diagnosis of gastric pathology. The optimal demonstration of the gastric wall is achieved by enhancement with intravenous contrast and distention of the lumen with fluid, using a positive or negative oral contrast. If there is a suspicion of wall thickening or intraluminal filling defect, the patient can be rescanned in different positions or in different phases of contrast enhancement (*Figure 10*).

However, computed tomography is not commonly used as the primary diagnostic investigation, as early gastric malignancy can be occult and finding of mural thickening is very non-specific. It will require endoscopy and biopsy to obtain the tissue diagnosis.

Magnetic resonance imaging

The oesophagus is one of the most challenging organs to assess with magnetic resonance imaging, because of its collapsed constitution and specific structure with very thin (around 2 mm) walls. Adjacent organs (the heart, the aorta and respiratory system) produce multiple movement artefacts overlying the image of oesophagus. A few small series have been published, based on examination of volunteers and cadavers, which show promising data (Riddell et al, 2006, 2007). However, further studies are needed to establish an optimal sequences for this imaging modality.

Similar to computed tomography examination, the stomach can be better visualized on a magnetic resonance imaging examination than the oesophagus, especially with oral and intravenous contrast (*Figure 11*). Unfortunately, magnetic resonance imaging has the same limitations as computed tomography imaging and is more useful as a staging examination than a primary diagnostic test. Gastric wall layers can not be distinguished on conven-

Figure 9. Computed tomography of abdomen with oral and intravenous contrast demonstrates metastatic gastric carcinoma. Soft tissue lesion (T) in the greater curvature extends through the wall into surrounding tissue. Also seen are enlarged lymph nodes (LN) in the epigastrium and metastasis in right adrenal gland (M).

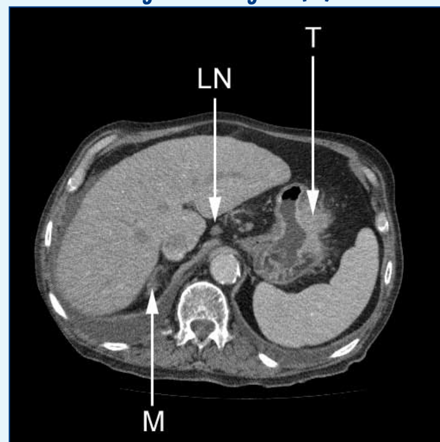
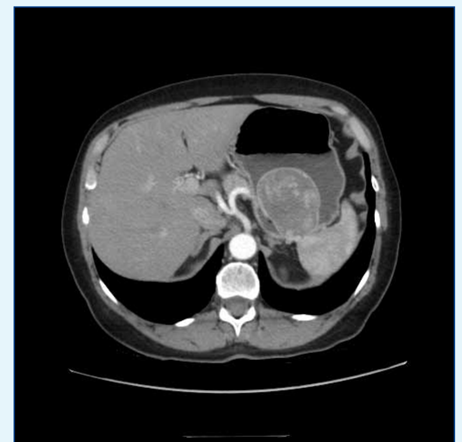


Figure 10. Large polypoid lesion in the proximal part of the stomach seen on computed tomography of the abdomen – scan has been performed in the arterial enhancement phase, with negative oral contrast.



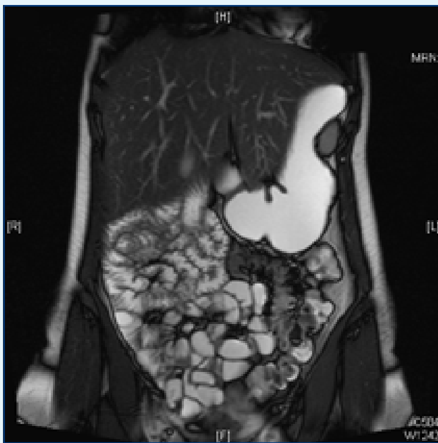


Figure 11. Magnetic resonance imaging of the abdomen shows normal appearance of the stomach. Gastric wall and lumen is well visualized because of the use of oral contrast and good distention.

tional magnetic resonance imaging images, which limits accuracy of tumour staging. Endoscopic magnetic resonance imaging is the most promising technique, which may provide better differentiation between tumour and peri-tumour tissue changes often associated with gastric carcinoma.

Magnetic resonance imaging is performed occasionally to answer specific clinical dilemmas. It can very accurately show an invasion of the adjacent structures, involvement of lymph nodes or delineating the position of tracheo-oesophageal fistula.

In some cases of large soft tissue lesions in the epigastrium, magnetic resonance imaging can help to establish the origin of the lesion and its detailed characteristics.

However, the motion artefacts (peristalsis, respiratory and patient movements), spatial resolution and image quality need to be addressed before magnetic resonance imaging is used commonly in diagnosis of oesophageal and gastric pathology.

Conclusions

Endoscopy and radiological examinations provide useful and complementary information in patients with upper gastrointestinal symptoms. Careful clinical examination and detailed knowledge of available investigations should ensure the best choice of diagnostic pathway and reduce unnecessary examinations and possible delays. BJHM

Conflict of interest: none.

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Further reading

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KEY POINTS

- Endoscopy and radiology remain important and complementary examinations in diagnosis of upper gastrointestinal disease.
- Endoscopy is preferred in patients with inflammatory and neoplastic conditions, when biopsy can be performed.
- Structural abnormality and motility disorders are best demonstrated with contrast techniques.