Transabdominal sonography of the gastrointestinal tract

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Abstract Like other cross-sectional imaging methods, transabdominal sonography is increasingly used for evaluation of gastrointestinal diseases. The potentials and limitations of sonography in evaluation of the gastrointestinal tract are discussed. Transabdominal sonography proved to be of clinical value in assessment of appendicitis, diverticulitis, bowel obstruction, chronic inflammatory bowel diseases, intussusception and infantile hypertrophic pyloric stenosis. The sonographic morphology of the most common gastrointestinal diseases is discussed. In experienced hands sonography can be used as primary imaging in several gastrointestinal diseases. The gastrointestinal tract should be included in the sonographic examination of the abdomen, especially if symptoms could be related to the intestine.

Keywords Transabdominal sonography · Appendicitis · Diverticulitis · Crohn’s disease · Bowel obstruction · Gastrointestinal tumours

Introduction

The clinical value of transabdominal sonography of the gastrointestinal (GI) tract is often under-appreciated. This may be caused by the variable sonographic appearance of the intestine. Furthermore, due to bowel gas, the posterior wall of the GI tract is often not visualized on transabdominal sonography; however, in many common and clinically important diseases, such as bowel obstruction, appendicitis, diverticulitis and Crohn’s disease, sonography plays an important role in the diagnosis [1, 2, 3, 4, 5].

The major drawback of GI tract ultrasound is that the results are extremely operator dependent. Furthermore, the sonographic diagnosis has to be made during real-time scanning.

Technique and sonographic anatomy

Except for acute situations, the patient usually fasts overnight before the examination. We recommend at least 6 h of fasting: firstly, to avoid excessive gas in the intestinal lumen, and secondly to reduce the amount of fluid in the intestine, which can be a sign of bowel obstruction, inflammatory diseases or malabsorption. In diabetic patients a light breakfast can be given. Depending on the clinical situation, the examination usually is started with a 3- to 5-MHz curved-array transducer.

It is important that graded compression be used for the sonographic investigation of the GI tract in order to transfer the air out of the region of interest [6].

Another important tip for demonstrating, for instance, the fluid behind the air levels in bowel obstruction is to scan in coronal or oblique sections. If associated portions of the GI tract are difficult to visualize in supine positions, it is recommended to investigate the region of interest in different positions (right anterior oblique or left anterior oblique).

Especially if pathology is found with a 3- to 5-MHz transducer, scanning of the regions of interest with a high-resolution transducer (5- to 10 MHz) should be attempted in order to have a better resolution and delineation of the pathology, especially in slim patients.
Stratification of the GI tract

Depending on the depths of the examined segment of the GI tract, the scan quality of the patient and the used frequency, three to five layers of the intestinal tract can be visualized [7, 8]. The sonographic layers and their anatomical correlations are listed in Table 1.

The thickness of the normal GI tract varies considerably. The wall of antrum of the stomach can measure up to 5 mm. Especially in this area contractions of the antrum can simulate pathology. In case of a borderline or moderately thickened GI region the same area should be reinvestigated within a few minutes in order to differentiate contractions from real pathologies.

In the duodenum and the small bowel the wall thickness of the GI tract is usually 1–2 mm. This was found in a prospective study where the small bowel wall was measured in normal patients in a non-contracted status during moderate compression [65]. Sometimes it is difficult to determine the inner boundaries of the small bowel lumen. In these cases the anterior–posterior diameter of the empty bowel is measured during compression and divided by two.

In the large bowel, especially in the sigmoid colon, the normal wall thickness can measure up to 3 mm. If there is a significant amount of air in the large bowel, or if the bowel is distended, the wall of the colon is often hardly seen with a low-frequency transducer.

The width of the lumen of the GI tract also varies considerably. In the small bowel the width of the GI tract usually can be evaluated. In this region the measurement of fluid-filled bowel loops is important in order to evaluate bowel obstruction. The lumen of the small bowel measures usually less than 2 cm in width.

The peristalsis of the GI tract can be evaluated sonographically.

In bowel obstruction it can be decided whether the intestinal tract is akinetic (paralysed) or if the bowel loops show hyperperistaltic contractions. Also in acute infections of the small bowel hyperperistalsis often is present.

It has to be mentioned that certain areas are more constantly visualized sonographically than others (Table 2). These areas can be regarded as landmarks of the GI tract.

The fundus of the stomach, the region of the duodenal–jejunal junction, the left colonic flexure, the distal sigmoid colon and the sigmoid–rectal junction and the distal rectum are sonographically difficult to visualize, since often superposition of other bowel segments occurs; however, pathologically thickened bowel loops are usually easier visualized than the normal GI tract, because the thickened, hypoechoic, pathological bowel wall contrasts with the surrounding moderately echogenic fat.

Table 1 Sonographic layers of gastrointestinal tract and their anatomical correlations

<table>
<thead>
<tr>
<th>Echogenic layer</th>
<th>Entrance echo and superficial mucosa</th>
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</thead>
<tbody>
<tr>
<td>Hypoechogenic layer</td>
<td>Deep mucosa, muscularis mucosae</td>
</tr>
<tr>
<td>Echogenic layer</td>
<td>Submucosa</td>
</tr>
<tr>
<td>Hypoechogenic layer</td>
<td>Muscularis propria</td>
</tr>
<tr>
<td>Echogenic layer</td>
<td>Serosa and exit echo</td>
</tr>
</tbody>
</table>

Table 2 Sonographic landmarks of the gastrointestinal tract

<table>
<thead>
<tr>
<th>Gastro-oesophageal junction</th>
<th>Antrum of the stomach</th>
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<tbody>
<tr>
<td>Cecum</td>
<td>Ascending colon</td>
</tr>
<tr>
<td>Transverse colon</td>
<td>Descending colon</td>
</tr>
<tr>
<td>Sigmoid colon</td>
<td>Rectum (retrovesical)</td>
</tr>
</tbody>
</table>

Stomach

Inflammatory diseases as gastritis or ulcers are usually not detected by sonography. Intraluminal fluid in the stomach may be a non-specific sign of these diseases. Occasionally, circumscribed thickening of the gastric or duodenal wall with an echogenic centre is seen in gastrointestinal ulcers [9, 10, 11].

The application of water may enhance the accuracy of sonography in visualisation of gastric ulcers.

Significant complications, such as penetrations of ulcers into the liver or pancreas, may be detected sonographically [12]. Perforation of an ulcer may be detected by visualisation of free intraperitoneal air. The accuracy of sonography in diagnosing perforation is comparable or superior to plain X-ray film [13, 14, 15]. Usually free abdominal air is found in front of the left lobe of the liver (Fig. 1). In right anterior oblique position the air is visualized in front of the right lobe of the liver. Meticulous sonographic examination technique must be used not to miss little amounts of free intra-abdominal air. As with plain X-ray films, it is difficult to visualize localized air in atypical extraintestinal localizations. In these conditions CT has a significantly higher accuracy than sonography.

Transabdominal sonography has only a moderate value in the detection of gastric tumours [16]. Sonography may play a role in the detection of scirrhous carcinoma (the limitis plastica growth type); these are mainly submucosal growing lesions. It is very difficult to diagnose scirrhous carcinoma endoscopically. Usually these lesions sonographically show significant thickening of the gastric wall. In scirrhous carcinoma and advanced lymphoma the gastric wall thickness usually exceeds 10 mm and the normal stratification is lost (Fig. 2). Furthermore, the normal motility of the stomach is lost. The thickened gastric wall is very rigid during real-time scanning. In these usually eye-catching lesions, the sonographic diagnosis should be further enhanced by a barium study, if endoscopy fails to make the diagnosis.