

Section 2.1.2 Abdominal pain

Patients with acute abdominal pain present a diagnostic and management challenge to the general surgeon. Plain abdominal radiographs remain the first imaging investigation in these patients, and may provide a specific diagnosis in some cases. Increasingly, additional imaging with US, CT and MRI is performed early in the management of these patients to facilitate a rapid definitive diagnosis.

2.1.2.1 Small bowel obstruction

In mechanical small bowel obstruction (SBO), swallowed air and intestinal secretions fill the dilated proximal small bowel and there is reduction in the calibre and gas content of large bowel distal to the obstruction. Features of SBO on plain abdominal radiograph are:

- Dilated gas-filled loops of small bowel, greater than 3 cm diameter, which tend to be central, numerous and in the case of the jejunum have valvulae conniventes that extend right across the bowel.
- Multiple fluid levels on an erect abdominal radiograph.
- “String of beads” sign on an erect abdominal radiograph, due to small amount of gas trapped between valvulae conniventes.
- The small bowel may be completely filled with fluid, especially with a longer standing degree of obstruction, giving the appearance of “gasless” abdomen
- Absence of gas or faeces in the large bowel
- All the above signs may be absent in proximal SBO, where a dilated stomach may be the only sign

These changes may appear after 3-5 hours and are usually present after 12 hours from the onset of symptoms. Often the plain abdominal radiograph will not show the cause of obstruction but there are several important causes that should be diagnosed on plain radiographs. The presence of gas below the line of the inguinal ligament may indicate an incarcerated femoral or inguinal hernia, a cause of SBO in about 15% of cases. Gas in the biliary tree and an opaque gallstone in the right iliac fossa are the classic features of a gallstone ileus. It should be remembered that adhesive disease is the cause of SBO in about 50% of cases.

CT will confirm the presence of SBO and also provide additional information regarding the level and the cause of obstruction. It will, in addition, give staging information if a malignancy is the cause of SBO. CT is the imaging technique of choice in diagnosis of small bowel strangulation, being of great value in urgent surgical management of these patients.

2.1.2.2 Large bowel obstruction

The most common cause of large bowel obstruction (LBO) in the western world is a tumour, with rectosigmoid carcinoma being the commonest (65% at this location).

This is closely followed by diverticulitis. Because, LBO affects much more commonly left colon, plain abdominal radiographs usually suggest the diagnosis.

Dilated (more than 5 cm diameter), gas-filled loops of large bowel that tend to be peripheral and few in number are seen proximal to the level of obstruction with little or no gas present distal to it. If the ileo-caecal valve is competent, little or no gas is seen in the small bowel whereas multiple dilated gas-filled small bowel loops are present when the ileo-caecal valve is incompetent. In the latter, the appearances can be identical with pseudoobstruction (see later). With long standing obstruction, the caecum is at risk of perforation.

Single contrast enema is often performed as an emergency investigation prior to surgery in order to confirm the presence and determine the level of obstruction.

Usually the information provided by the combination of plain abdominal radiograph and contrast enema is adequate for appropriate surgical management. In the situations when the plain radiograph findings are equivocal or when the patient is unable to tolerate a contrast enema, CT can provide comparable information regarding the level and cause of obstruction as well as staging information if a colonic carcinoma is demonstrated.

Caecal volvulus is a surgical emergency and the diagnosis can be promptly made on a plain abdominal radiograph with no need for further imaging. Features of caecal volvulus are:

- Markedly dilated caecum containing few haustral markings
- Large gas-filled viscus which may lie virtually anywhere in the abdomen, but more frequently positioned in the left upper quadrant
- Marked gaseous or fluid distension of the small bowel, which also fills the empty right iliac fossa
- Attached gas-filled appendix
- Collapse of the left side of the colon

Sigmoid volvulus usually occurs in the elderly or institutionalised psychiatric patients. The diagnosis should be confidently made on a plain abdominal radiograph. Barium enema may be used in equivocal cases. Features of sigmoid volvulus are:

- A dilated ahaustral bowel loop with apex under the left hemidiaphragm, above the level of the T10 vertebra
- “Coffee bean” sign – markedly dilated loop of sigmoid colon with a distinct midline crease that corresponds to twisted mesenteric root
- “Bird of prey” sign – tapered end of barium column on barium enema

2.1.2.3 Pseudoobstruction

Pseudoobstruction or Ogilvie's syndrome is marked colonic distension without a mechanical obstructing cause that may occur as a result of pharmacological, biochemical, neural, endocrine and myopathic factors. It usually occurs in the elderly patient and may be self-limiting or associated with common medical conditions such as chest infection, myocardial infarction etc. Plain abdominal radiographs may be indistinguishable from LBO, demonstrating dilated large and small bowel loops and a single contrast enema or CT is usually indicated to exclude mechanical obstruction, in order to avoid inappropriate surgical intervention which can be disastrous.

2.1.2.4 Perforation of hollow viscus

The most common cause of pneumoperitoneum is perforation of peptic ulcer followed by diverticulitis and malignancy. An erect chest radiograph and an abdominal radiograph, usually taken supine, should always be obtained if perforation is suspected. Both are very sensitive and as little as 1 ml of free air can be detected on an erect chest radiograph or a left lateral decubitus abdominal radiograph. On the erect chest radiograph air is seen under one or both diaphragms, and if under both results in the "continuous diaphragm" sign.

Signs of free intraperitoneal air on a supine abdominal radiograph are:

- Air overlying or outlining solid organs such as liver and spleen – "lucent liver" sign
- A triangle of air outlining Morrison's pouch - "Doges cap" sign.

- Air outlining intra-abdominal structures such as falciform ligament, umbilical median, medial and lateral ligaments – “inverted V” sign
- Bowel wall outlined by air both inside and outside – “Rigler’s” sign
- Centrally placed intra-peritoneal free air – “football” sign, and scrotal air in children
- “Cupola” sign of air under the central diaphragm

It is very important to be able to recognise conditions that can simulate pneumoperitoneum as an observational error may lead to unnecessary surgery.

Chilaiditi’s syndrome in which the colon is interposed between the liver and the diaphragm can mimic pneumoperitoneum but usually haustral folds can be seen that will allow identification of the colon. A gas containing subphrenic abscess may also mimic a pneumoperitoneum as can basal pulmonary atelectasis. On the left side a gas-distended fundus of the stomach may cause confusion and clarification by a decubitus film may be necessary. Post operative air may sometimes cause confusion but this should have resolved by 5-7 days and should decrease in size with time.

Where the plain radiographs are equivocal then CT is the most sensitive imaging technique for diagnosis of free intra-peritoneal air. Small amount of free intra-abdominal air can be seen anterior to the liver or midline abdomen (as the mobile air collects anteriorly with the patient in the supine position), and in the peritoneal recesses or retroperitoneal spaces. This is best appreciated on by reviewing the images on “lung window” settings. CT may identify the cause of pneumoperitoneum and can offer additional information to plain radiographs. X-ray contrast studies can also be performed

to confirm a perforation. Water-soluble contrast medium administered orally or via a nasogastric tube combined with fluoroscopic imaging can often identify the location of a perforation in the proximal GI tract. Urgent surgery is usually required for a perforated hollow viscus.

2.1.2.5 Acute appendicitis

Acute appendicitis is the most common cause of an abdominal surgical emergency. The diagnosis usually made on the basis of clinical history and physical examination with no need for imaging. Sometimes however the clinical findings are equivocal and increasingly CT is used to confirm the diagnosis, although concerns about radiation exposure indicate that it should only be used when appropriate.

Plain abdominal radiographic findings are non-specific and usually unhelpful. They may show an appendicolith. CT is the most accurate technique for confirming the diagnosis of appendicitis and assessing the severity and possible

Plain abdominal radiograph findings in acute appendicitis

- Calcified appendicolith (10%)
- Right iliac fossa mass
- Localised ileus
- Loss of right psoas margin and blurring of peritoneal fat line
- Extraluminal gas collections
- Pneumoperitoneum
- Scoliosis concave to the right

complications, with a sensitivity and specificity of 100% and 95% respectively. CT findings include a distended appendix measuring more than 6 mm in diameter, which is thick-walled and may enhance following administration of intravenous contrast medium. An appendicolith can be seen in 25% of the cases. Associated inflammatory changes include streaking of the periappendiceal fat, fluid collection owing to abscess formation,

thickening of the caecal and/or terminal ileum wall, and thickening of the anterior renal and adjacent fascial planes.

Graded compression US has a recognised value in the diagnosis of acute appendicitis in children. Graded compression is applied with the transducer over the right iliac fossa in order to displace bowel gas and examine the appendix. In a patient with appendicitis, the appendix appears as a tubular noncompressive, aperistaltic structure that measures more than 7 mm in its transverse diameter. An appendicolith, casting posterior acoustic shadowing, may be seen. The surrounding inflammatory mass appears heterogeneous and an abscess or fluid collection may be present. US in expert hands potentially offers a sensitivity and sensitivity of 98%. The choice between US and CT depends of the local availability and expertise but US is preferred in children and pregnant women due to lack of ionising radiation, and in younger women where there is higher incidence of pelvic inflammatory disease. Imaging, however should not be a substitute for adequate clinical skills, and should only be requested when there is clinical uncertainty, thus avoiding the delay in prompt surgical treatment or inappropriate radiation exposure

2.1.2.6 Acute cholecystitis

Acute cholecystitis results from cystic duct obstruction by an impacted gallstone in over 90% of cases. Patients usually present with classical symptoms and signs of right upper quadrant pain and tenderness, and the diagnosis will be confirmed by US if surgery is contemplated during the first admission. Apart from confirming the diagnosis, US may detect other causes of acute abdominal pain such as right renal obstruction.

Plain abdominal radiograph findings are non-specific and usually unhelpful. They include calcified gallstones (20%), right upper quadrant mass due to an enlarged gallbladder, duodenal or high colonic ileus, and rarely air within the biliary tree (in cases of gallstone ileus).

On ultrasound the two most important features are the presence of gallstones and maximal tenderness on compression over the gallbladder (sonographic “Murphy’s” sign) which is highly specific for acute cholecystitis. Both scintigraphy using ^{99m}Tc labelled derivatives of

iminodiacetic acid (HIDA) and US are diagnostically accurate and the choice between them may reflect local

Ultrasound features in acute cholecystitis

- Gallstone – mobile hyperechoic fossi that cast posterior acoustic shadowing
- Tenderness on compression over the gallbladder (sonographic “Murphy’s” sign)
- Thickening of gallbladder wall greater than 3mm
- Pericholecystic fluid
- Distended gallbladder

expertise and availability. HIDA-scintigraphy has a 100% negative predictive value and a good sensitivity. A positive examination consists of non-visualisation of gallbladder but prompt visualisation of the common bile duct and duodenum one hour after injection. False positive results occur in alcoholic liver disease and in patients receiving parenteral nutrition.

CT is not the primary imaging modality due to its low sensitivity for gallstones. It is however of good value in imaging possible complications such as gangrenous

cholecystitis, perforation of gallbladder resulting in abscess formation or biloma, Mirizzi's syndrome, etc.

2.1.2.7 Acute pancreatitis

The most common cause of acute pancreatitis in Western countries is alcohol followed by cholelithiasis. Less frequent causes are metabolic disorders such as hyperparathyroidism, trauma, abdominal surgery, viral infections, drugs etc. The plain abdominal radiograph is unreliable, being normal in over 75% of patients with acute pancreatitis, but can demonstrate a number of features (see table).

The diagnosis of acute pancreatitis is usually straight forward based on clinical history, findings and hyperamylasaemia. In these cases US is primarily indicated to detect the presence of

Plain film findings in acute pancreatitis

- Gallstones
- Pancreatic calcifications with chronic pancreatitis
- Gasless abdomen
- Generalised or paralytic ileus in the left upper quadrant
- Sentinel loop and colon cut-off sign
- Separation of greater curve of stomach from transverse colon
- Loss of left psoas outline
- Extra-luminal air bubbles
- Left pleural effusion
- Elevated left hemidiaphragm

gallstones as a possible cause as the pancreas is not always visible due to the accompanying small bowel ileus. When visualised, the pancreas may be enlarged, hypoechoic and ill defined. Peripancreatic fluid and possible complications such as abscess and pseudocyst formation can be identified. US is unable to accurately assess

pancreatic necrosis which many consider the single most important determinant of morbidity and mortality in these patients.

CT more reliably demonstrates all these features more reliably (except for gallstones). In particular it is the imaging technique of choice to assess the presence and extent of pancreatic necrosis. Following intravenous contrast medium administration thin, small field of view sections are obtained during pancreatic phase enhancement in addition to conventional arterial and venous phases. In cases of mild acute pancreatitis, the pancreas may appear normal. More commonly the gland appears enlarged with increased attenuation in the peripancreatic fat and adjacent fascial plane thickening. The pancreas itself normally shows homogeneous enhancement but in severe acute pancreatitis necrotic tissue appears as areas of reduced or absent enhancement in the parenchyma. The presence of parenchymal air is highly suggestive of infection although fistulation to the gastrointestinal tract can result in identical appearances. CT is very sensitive for demonstrating complications such as pancreatic abscess, adjacent fluid collections or pseudo-cyst formation. It is particularly helpful for vascular complications including both pseudo-aneurysm formation and thrombosis of the splenic or portal vein. The Balthazar CT Severity Index, which has been shown to have a good correlation with morbidity and mortality of the disease, can be calculated on the basis of the CT findings.

Recommendations for contrast-enhanced CT in acute pancreatitis

- Patients who do not improve within 72 hours of the commencement of conservative management
- To confirm the diagnosis of acute pancreatitis and to evaluate the extent and severity of disease
- Patients with a Ranson score greater than three
- To diagnose complications
- To guide interventional procedures

2.1.2.8 Small bowel ischemia

Different processes can lead to small bowel ischemia, the most common being mesenteric thrombus or embolus, infiltration and trauma. It represents a serious surgical condition that can be difficult to diagnose clinically and often requires prompt imaging and treatment.

Plain abdominal radiographic findings depend on the severity of the disease. Non-specific dilated bowel loops with multiple fluid levels or fluid filled loops are a frequent finding. Thickening of the bowel wall (“thumb printing”) may be visible which is due to submucosal haemorrhage and oedema. In severe cases, gas may be seen within the bowel wall and/or the mesenteric and portal veins. Barium studies will show separation of the bowel loops and thickening of valvulae conniventes. Mucosal ulceration can be seen in advanced cases.

Contrast enhanced CT may provide an early diagnosis of mesenteric ischemia, not only by demonstrating the dilated fluid filled loops of bowel with wall thickening and ascites, but more importantly the lack of mesenteric vascular enhancement following administration of intravenous contrast media. Occasionally thrombus may be visible in a mesenteric artery or vein and gas within the mesenteric veins and/or bowel wall.

Reconstruction of vascular anatomy using multislice CT will further assist in an accurate diagnosis.

Angiography was widely used to make the diagnosis prior to CT and remains valuable for equivocal cases. It will show features of occlusion, vasoconstriction or vascular beading. Emboli are typically seen at major branching points distal to the first 3 cm of superior mesenteric artery.

2.1.2.9 Renal colic

Renal colic is usually caused by stone disease but may also arise secondary to a transitional cell carcinoma of the renal pelvis or ureter. Micro or macroscopic haematuria occurs in most cases.

Urolithiasis: Imaging is almost always required to make an initial diagnosis, but may not be needed for uncomplicated recurrent disease. Plain abdominal radiograph may show a calcified opacity along the line of the urinary tract, but up to 30% of the stones are not calcified (or obscured). Intravenous urography (IVU) is helpful in showing the degree and site of obstruction. Features of obstruction include dilatation of the pelvicalyceal system and/or the ureter, depending on the position of the stone. US may show renal stones and features of hydronephrosis but it has to be remembered that the pelvicalyceal system may appear normal in the early phase of obstruction. US can not reliably demonstrate ureteric stones. Non-enhanced CT (NECT) is increasingly used as the imaging modality of choice when urolithiasis is suspected. It has a sensitivity and

specificity of 97%, with a calculus within the ureter being pathognomonic. It can detect radiolucent stones as well as ureteric oedema surrounding a small impacted stone. Stranding of the perinephric/periureteral fat and perinephric fluid collections are associated findings easily detectable by CT. Confusion can arise from the presence of phleboliths, but multiplanar reformats in coronal and sagittal planes will help resolve the dilemma.

Transitional cell carcinoma: Plain abdominal radiograph is usually normal. IVU shows single or multiple filling defects in the renal pelvis, ureter or bladder. One or more calyces may also fail to opacify (“phantom calyx”) or there may be calyceal distension with tumour (“oncocalyx”). Hydronephrosis due to tumour obstruction is an additional but uncommon finding. US confirms these findings but CT is indicated for staging purposes.

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