Interpretation of the abdominal radiograph: 2

Introduction

This article discusses important emergency conditions that may be diagnosed on the abdominal radiograph highlighting the key radiological signs that should be recognized.

Volvulus

Volvulus accounts for approximately 10% of cases of large bowel obstruction. Volvulus occurs where the mesentery is longest allowing that segment to twist. The commonest site is the sigmoid followed by the caecum.

Sigmoid volvulus is common in African and Asian countries because of their high fibre diet. In the west patients are commonly elderly, or psychiatric cases. The sigmoid becomes a greatly distended, paralysed ahaustral loop and this has the appearance of a coffee bean on the supine radiograph (*Figure 1*). It arises from the left side of the pelvis and extends superiorly to the right side of the abdomen.

Caecal volvulus occurs in a younger age group of 20–40 years. In about 50% of patients, the caecum twists and inverts so that the caecum is sited in the left upper quadrant. In the other 50% the caecum twists in the axial plane without inversion so that the caecum remains in the right lower quadrant (*Figure 2*). On the abdominal radiograph the volvulus appears as a kidney-shaped distension of the caecum. There are usually a few haustral markings compared to a complete absence in sigmoid volvulus. Small bowel obstruction is often associated with collapse of the left colon.

Figure 1. There is a markedly distended loop of bowel arising from the pelvis and extending to the left upper quadrant. The loop has the appearance of a 'coffee bean'. There are no haustral markings of the bowel loop. Appearances are consistent with a sigmoid volvulus with proximal large bowel obstruction.

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Figure 2. There is a large dilated loop of bowel with thickened wall in the right iliac fossa consistent with a caecal volvulus. There is associated small bowel obstruction but no large bowel dilatation.

Gall-stone ileus

Gall-stone ileus (*Figure 3*) is an uncommon cause of small bowel obstruction (about 1%) but has a high mortality. However, with increasing age it becomes a more likely cause of intestinal obstruction (25% in patients over 70 years). Gall-stones enter the small bowel via a fistula. This is most commonly cholecystoduodenal (60%) and results in aerobilia seen as branching lucencies arising from the liver hilum in contrast to the peripheral air present with portal venous gas. The gall-stone needs to be >2.5 cm to cause small bowel obstruction. The gall-stone most commonly impacts in the terminal ileum (60–70%).

The classic plain radiograph triad (Rigler's triad) is: intestinal obstruction (80%), gas in the biliary tree (70%) and an ectopic calcified gall-stone (25%).

Figure 3. Gall-stone ileus. There is aerobilia (arrows), small bowel obstruction and multiple radio-opaque gall-stones in the gall bladder. Pelvic densities are present one of which is the impacted stone at the ileocaecal valve.

Intussusception

Intussusception is one of the most common abdominal emergencies of early childhood (*Figure 4*). It is most commonly ileocolic (75–95%) in children compared with ileo-ileal (40%) in adults. The aetiology is idiopathic in over 95% in children and is thought to be caused by lymphoid hyperplasia of Peyer's patches. In adults 80% have a specific cause, including: benign neoplasm (one third), malignant neoplasm (one fifth), Meckel's diverticulum, foreign body and trauma.

The diagnosis often requires a high level of suspicion. The plain radiograph is normal in 25%, but shows an abdominal soft tissue mass in 50% (commonly in the right upper quadrant). Small bowel obstruction is present in 25%.

Figure 4. Intussusception in a 15-month-old boy. There is a soft tissue mass surrounded by a thin crescent of air just inferior to the liver (arrow) consistent with an intussuscepted caecum or ascending colon. Note the absence of bowel gas in the right iliac fossa. There is no free intraperitoneal gas or evidence of small bowel obstruction.

Acute colitis

The abdominal radiograph can be used to assess the extent of mucosal involvement in acute colitis. The disease in unlikely to be active where there is formed faeces. The depth of ulceration, perforation and presence of toxic megacolon (*Figure 5*) can all be made on plain film. Toxic megacolon is caused by transmural fulminant colitis with neuromuscular degeneration. This results in rapid colon dilatation (>5.5 cm is abnormal). Typically there is loss of the normal haustral pattern with bowel wall thickening and pseudopolyposis (mucosal islands in denuded ulcerated colonic wall).

It is important to differentiate toxic megacolon from other causes of a dilated colon where the mucosal pattern will be normal, e.g. ileus, pseudo-obstruction and true obstruction. As well as the radiological findings, the diagnosis is also based on the patient's clinical condition, i.e. the presence of pyrexia, tachycardia and leucocytosis. Perforation and ensuing peritonitis may occur with a high mortality (>20%). Perforation may be heralded by linear air within the bowel wall.

Figure 5. Toxic megacolon. The transverse colon is grossly dilated at 12 cm with thickening of the bowel wall. Mucosal islands (pseudopolyps) are present which represent areas of normal mucosa.

Ischaemic colitis

Ischaemic colitis most commonly affects the splenic flexure and descending colon. Radiologically it is characterized by bowel wall thickening (described as thumbprinting as a result of bowel wall oedema and haemorrhage). A functional obstruction occurs with proximal colonic dilatation. The development of linear intramural gas heralds necrosis which may be followed by perforation. Portal venous gas is a poor prognostic sign.

Trauma

Plain radiography is rarely indicated when investigating blunt or penetrating injury. Computed tomography (CT) is the most useful modality in the assessment of abdominal injury if the patient is haemodynamically stable and does not require urgent laparotomy. However, often the abdominal radiograph is used as the first investigation in the initial assessment while waiting for other imaging.

Liver and splenic injury should be suspected in lower rib fractures or elevation of the hemidiaphragms. The gastric air bubble may be displaced medially by a splenic haematoma. Bleeding into the paracolic gutters will result in widening of the space between the ascending or descending colon and the properitoneal flank stripe. Intestinal injury may manifest as free intraperitoneal gas or retroperitoneal gas in rupture of the third part of duodenum (*Figure 6*). Abdominal may be useful in identifying shrapnel and foreign bodies.

Figure 6. Retroperitoneal gas outlining the kidneys secondary to a ruptured third part of duodenum.

Renal colic

Approximately 90% of all renal tract calculi are radio-opaque (*Figure 7*). They need to be distinguished from pelvic phleboliths which have a lucent centre and a smooth spherical contour. A plain film is usually performed as part of an intravenous urogram (IVU) to exclude obstruction. Complications of an obstruction such as an urinoma or emphysematous pyelonephritis (*Figure 8*) can be diagnosed.

A urinoma is caused by a rupture of the pelvicalyceal system resulting in a retroperitoneal collection of urine and may be suspected on plain film in the presence of a soft tissue mass obscuring the renal and psoas contours. It is usually confirmed by IVU. Emphysematous pyelonephritis and emphysematous cystitis, which are more common in diabetics, are seen as linear gas tracts in the renal tubules and bladder wall.

Acute appendicitis

There are no specific radiological signs of acute appendicitis. The combination of an appendolith and abdominal pain equates with a 90% probability of acute appendicitis (*Figure 9*). Plain film signs include:

- Calcified appendolith 7–15%
- Caecal ileus (sentinel loop) (gas fluid level in gangrene)
- Extraluminal gas (in 33% of perforations). Pneumoperitoneum and pneumoretroperitoneum are rare

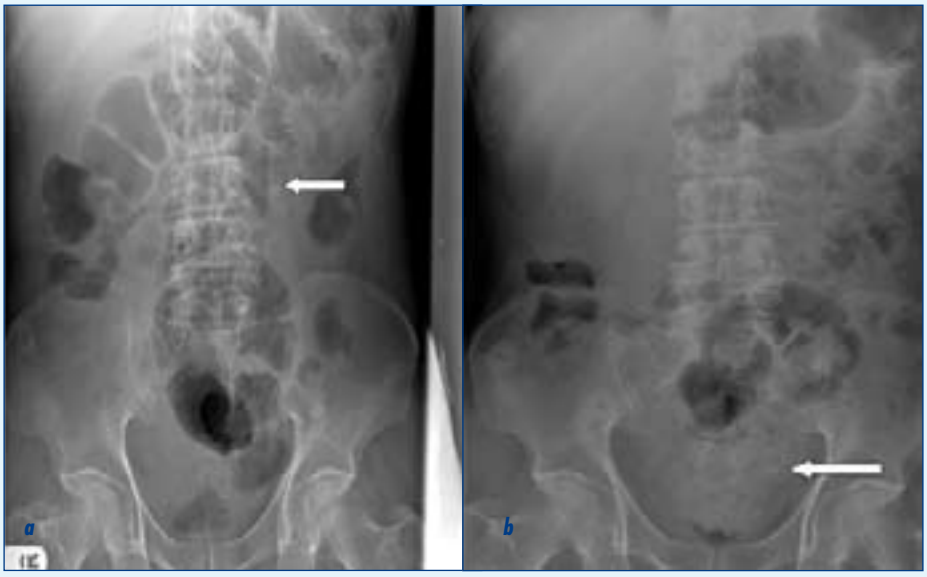

Figure 7. Left ureteric stone. a. There is a 1 cm stone at the left pelvicalyceal junction (arrow). b. On follow-up film the stone has passed distally and impacted at the left ureterovesical junction (arrow) causing obstruction.

- Small bowel ileus. Obstruction may occur associated with an abscess
- Blurring and widening of the properitoneal flank stripe
- Colon cut-off sign (amputation of gas at the hepatic flexure) as a result of spastic ascending colon
- Gas in the appendix. This is unreliable and may be seen in normals, ileus and large bowel obstruction
- Scoliosis concave to the right.

The diagnosis is usually made clinically or by ultrasound or CT.

Figure 8. Emphysematous pyelonephritis. Streaks of gas are seen in the renal parenchyma radiating from the medulla to the cortex (arrow). There is also an associated small bowel ileus.

Acute cholecystitis

Only one third of films show any abnormality. Signs include:

- Gall-stones – radio-opaque in 20%
- Pneumobilia (however, this sign has many causes)
- Duodenal or hepatic flexure ileus
- Right hypochondrial mass as a result of a distended gall bladder
- Air in the gall bladder wall is seen in emphysematous cholecystitis.

The diagnosis is best made by ultrasound.

Acute pancreatitis

A large number of signs have been described on plain radiography, most of which are of little use in the diagnosis of this condition. These include:

Figure 9. Acute appendicitis. There is a calcified appendolith (arrow) in the right iliac fossa with an associated small bowel ileus.

Rare but diagnostic

- Gas in the pancreas

Common and sometimes helpful

- Atonic stomach or duodenum
- Small bowel ileus
- Sentinel loop
- Loss of left psoas outline
- Dilated colon

Uncommon and unhelpful

- Pancreatic calcification
- Radio-opaque gall-stones
- Pleural effusion, basal atelectasis or elevated hemidiaphragm
- Loss of right psoas outline.

CT is the best modality for confirming the diagnosis and imaging complications such as pseudocysts and abscesses. BJHM

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Further reading

Dahnert W (2002) *Radiology Review Manual.* 5th edn. Lippincott, Williams and Wilkins, London

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Nicholson DA, Driscoll PA, eds (1996) *ABC of Emergency Radiology.* BMJ Publishing Group, London

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KEY POINTS

- Major trauma is best assessed by computed tomography.
- Check the bones and extrathoracic soft tissues.
- In acute colitis plain abdominal radiography may be used to assess the extent of involvement and to identify complications such as perforation and toxic megacolon.
- Ninety per cent of renal calculi are radio-opaque and therefore detectable on the abdmonial radiograph. Intravenous urography is necessary to exclude obstruction.
- Remember that myocardial infarction, pulmonary embolism, basal pneumonia and dissecting thoracic aortic aneurysms may present as an acute abdomen.