

X-ray quiz: an 8-year-old girl with abdominal pain

X光照片猜謎：一名肚子痛的八歲女孩

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Case scenario

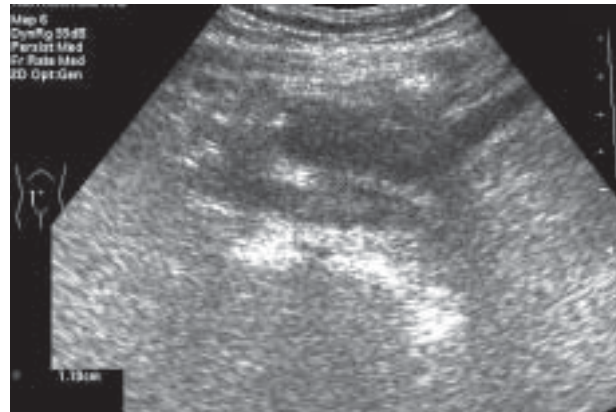
An 8-year-old girl attended an accident and emergency department and complained of generalised abdominal pain and low grade fever for three days. Her past medical history was unremarkable. On physical examination, there was localised tenderness and guarding over the right side of the abdomen. An abdominal X-ray was taken (Figure 1). Subsequently, ultrasound (USG) examination of the abdomen was also performed (Figure 2a & 2b).



Figure 1. Anteroposterior abdominal X-ray.

1. What is the abnormality in the abdominal X-ray?
2. What are the abnormalities in the USG images?
3. What other investigation would be helpful?

(a)



(b)

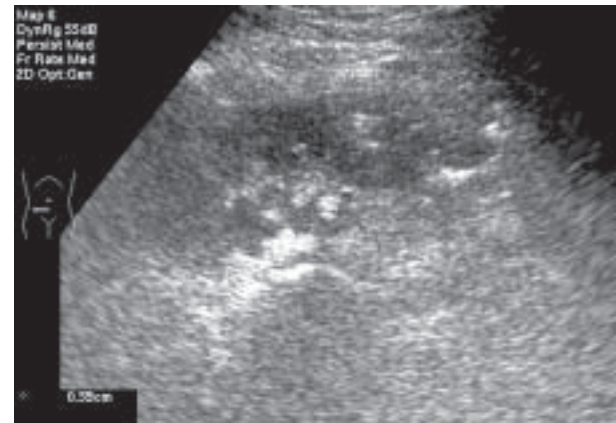


Figure 2. Ultrasound scans of the right lower quadrant of the abdomen: (a) longitudinal, (b) transverse.

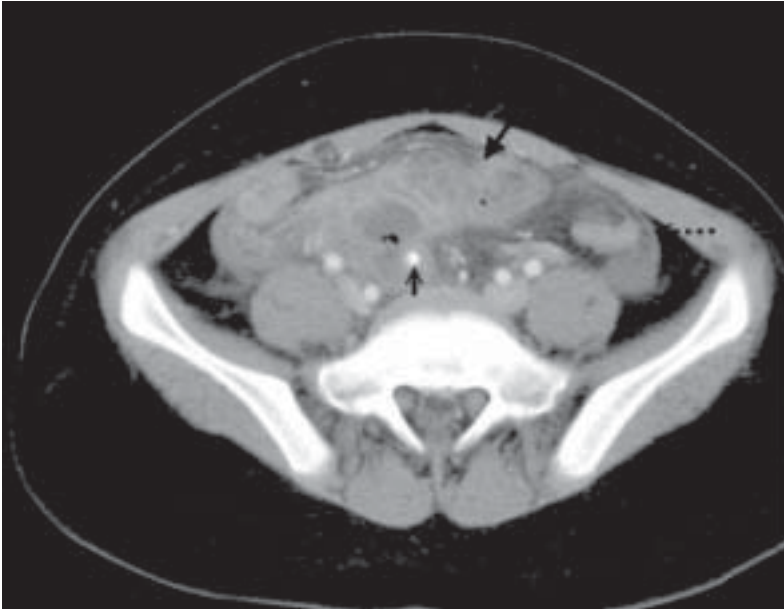
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She was then admitted to the surgical ward. In view of the increasing abdominal pain and elevation of white cell count, computed tomography (CT) of the abdomen and pelvis was performed (Figure 3a & 3b).

- 4. What are the lesion and its complication on the CT image?
- 5. What is the likely diagnosis?

(a)



(b)



Figure 3. Contrast enhanced computed tomography of the abdomen and pelvis: (a) axial plane, (b) coronal plane.

Answers

1. The abdominal X-ray (Figure 1) shows there is a paucity of bowel gas in the right lower quadrant of the abdomen. The gas shadow of the ascending colon is absent up to the hepatic flexure, known as "colon cut-off sign". A vague small opacity projected over the right paramedian S1 region is an appendicolith (arrow) which is much better shown in the USG and CT images.
2. Longitudinal USG scan (Figure 2a) demonstrates that there is a non-compressible aperistaltic blind-ended hypoechoic tubular structure of diameter 1.19 cm in the right lower quadrant of the abdomen. The adjacent fat is hyperechoic and there is an adjacent hypoechoic collection, reflecting inflammatory changes. Transverse USG scan (Figure 2b) reveals a ~5.9 mm echogenic focus with posterior shadowing present within the lumen of the inflamed hypoechoic tubular structure.
3. Contrast enhanced computed tomography of the abdomen and pelvis is another investigation to make the definitive diagnosis and look for the complications of the lesion.
4. Contrast enhanced CT abdomen and pelvis are reconstructed in both axial and coronal planes. Axial CT scan (Figure 3a) shows a lobulated hypodense collection with enhancing wall and gas pocket in the right lower quadrant of the abdomen. A small hyperdense opacity is present within the mass (smaller arrow), suggestive of a faecolith. The adjacent small bowel wall shows mural thickening (larger arrow). Inflammatory streaky densities in the mesenteries and fluid in left paracolic gutter are also present (dotted arrow). Reconstructed coronal image (Figure 3b) depicts abscess collection and an appendicolith (dotted arrow). The ascending colon shows marked mural thickening (larger arrow) and is spastic when compared with the descending colon which shows normal thin wall (smaller arrow). It is referred as the colon cut-off sign on the plain radiograph.
5. The diagnosis is acute appendicitis with perforation causing adjacent abscess collection. The small dense opacity within the collection was an appendicolith. Emergency operation revealed perforation of

the inflamed appendix with adjacent abscess collections.

Discussion

Acute appendicitis is a common surgical emergency condition. It accounts for 1-4% in children with acute abdominal pain.¹ The incidence peaks at the second decade of life, thereafter, the incidence decreases. The aetiology of acute appendicitis includes obstruction of the appendiceal lumen by lymphoid hyperplasia (60%), faecolith (33%), foreign bodies (4%), stricture, primary or metastatic tumour and parasite. It can also occur in Crohn's disease.¹

In most of the cases, the diagnosis is straightforward with typical clinical findings. Usual presentations include pain over the right lower quadrant referring to the epigastrium or periumbilical region; anorexia, nausea and vomiting. The patient can be afebrile or have low grade fever. There may also be leukocytosis.

However, particularly for children and the elderly, the clinical features are sometimes non-specific and difficult to diagnose. In these situations, radiology imaging can play an important role.

Plain radiograph of the abdomen does not always reveal abnormality. Actually, less than 50% show abnormality related to the disease.¹ There is no specific sign on plain film to diagnose acute appendicitis.² However, the radiographic findings may become more distinctive after perforation when findings simulate other diseases. Laminated calcified appendicolith in the right lower quadrant (RLQ) is shown in only 7-15% of the radiographs. The probability of acute appendicitis is up to 90% if an appendicolith is seen in a patient presenting with abdominal pain. Appendicolith in acute appendicitis means a high probability for gangrene or perforation.¹

Other radiographic features of acute appendicitis include abnormal changes in the ileocaecal bowel, small bowel dilatation, extraluminal gas, loss of fat planes

and scoliosis concave to the right on the abdominal X-ray. Inflammation of the ileocaecal region and appendix can appear as a water-density mass in the right lower quadrant with paucity or absence of intestinal gas. More severely, "caecal ileus" is seen which refers to the gas-fluid level in a gangrenous caecum. Moreover, amputation of bowel gas in the hepatic flexure may be seen due to a spastic ascending colon and this appearance is referred as "colon cut-off sign".¹

Whilst imaging cannot replace a good clinical history and physical examination, ultrasound and computed tomography have great potentials to improve diagnostic accuracy in patients with suspected appendicitis.

Graded-compression ultrasound, being a well-documented technique for examination of the appendix, is said to have 85% sensitivity and 92% specificity in diagnosing acute appendicitis.¹ The ultrasound probe is applied with increased pressure over the right iliac fossa in order to displace the bowel loops and examine the appendix.³ The normal diameter of the appendix is less than 6 mm. USG examination of acute appendicitis reveals a non-compressible appendix as a blind-ended aperistaltic tubular structure. It shows laminated wall with target appearance of ≥ 6 mm in diameter on cross section or mural wall thickness ≥ 2 mm.¹ Other sonographic features include pericaecal or periappendiceal fluid, increased periappendiceal fat echogenicity, mural thickening of adjacent terminal ileum and ascending colon as well as enlarged mesenteric lymph nodes. An appendicolith may be seen as an echogenic focus casting posterior shadow. Sonographic features suggestive of perforated appendix include non-visualisation of the appendix, loculated periappendiceal or pelvic collection and gas bubbles in the vicinity.

There are interpretative pitfalls of USG. False-negative ultrasound findings are due to failure to visualise the appendix because of inability to have adequate compression, aberrant location of the appendix (e.g. retrocaecal appendix) and appendiceal perforation. Early inflammation limited to the tip of the appendix can also lead to a false-negative result. On the contrary,

false-positive USG findings include normal appendix mistaken for appendicitis. Other diseases in the right lower quadrant and right sided pelvic cavity may mimic acute appendicitis and they include Crohn's disease, pelvic inflammatory disease and inflamed Meckel's diverticulum. Sometimes, colour Doppler USG may give further information to help making the diagnosis. It may demonstrate increased vascularity in and around the wall of the appendix due to hyperaemia.

It is important to note that USG is more useful in the clinically indeterminate group of patients, rather than when the diagnosis is considered very likely or very unlikely. USG is also helpful in detecting other conditions which share similar clinical presentations with acute appendicitis. It is particularly valuable in children when there is diagnostic doubt, and in young women (due to the higher incidence of tubal disease), especially in pregnant women as USG involves no radioactive hazard.²

Computed tomography is now used increasingly and is found to be a highly accurate test for confirming or excluding appendicitis. It carries a sensitivity and specificity of 100% and 95% respectively, as well as establishing alternative diagnoses in 89%.⁴ The overall accuracy is 93-98%.⁵ Normal appendix can be visualised more frequently (67-100%) on CT than on USG, which is the key advantage of CT over USG.³

On CT, the inflamed appendix is dilated to more than 6 mm in diameter with enhancing mural thickening. Surrounding inflammatory changes include increased fat attenuation, fluid, inflammatory phlegmon, caecal thickening, fascial thickening and lymphadenopathy. The "arrowhead sign" is present in 30% of cases and shows funnel of contrast medium in the caecum symmetrically centring on the occluded orifice of appendix.⁶ In case of perforation, the appendix may not be seen with adjacent abscess formation and extraluminal gas.

In summary, USG and CT achieve high sensitivity and specificity in diagnosing acute appendicitis or detecting other pathologies in an acute abdominal condition.

However, they may not be immediately available at every hospital. Therefore, a detailed history and a thorough clinical examination are still the cornerstone of the management of the acute abdomen. In case of real clinical doubt, imaging can certainly help to improve the diagnostic accuracy.

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