Pictorial review

Pitfalls in the CT diagnosis of appendicitis

1C D LEVINE, 2O AIZENSTEIN and 2R H WACHSBERG

1 Department of Radiology, University of Medicine in New Jersey, 150 Bergen Street, Newark NJ, USA and 2 Department of Radiology, Tel Aviv - Sourasky Medical Center, 6 Weizman Street, Tel Aviv, Israel

Abstract. CT evaluation of appendicitis represents an increasingly common emergency room request. While the overall accuracy of CT is high, numerous pitfalls exist which may deceive radiologists, resulting in a missed diagnosis of appendicitis. The inflamed appendix may be unusual in its location, or may appear normal if only a small portion of the distal appendix is involved (tip appendicitis). In a patient with a history of appendectomy, inflammation of the appendiceal stump may be easily missed. Appendicitis may closely mimic small bowel obstruction, or gynaecological disease, especially after perforation has occurred. Even a misleading clinical history may lead the radiologist’s eye astray. This pictorial review demonstrates these and other potential radiological pitfalls, and includes important points for the accurate diagnosis of appendicitis.

Appendicitis represents an exceedingly common clinical entity requiring prompt surgical intervention. In most cases, clinical symptoms and signs suffice as a basis for a decision to operate. The use of imaging in the evaluation of the right lower quadrant as an aid to operative decision-making has increased dramatically over the last few years. CT provides a rapid complete diagnostic evaluation of the right lower quadrant, with reported accuracy rates in the diagnosis of appendicitis of up to 95–100% [1]. In order to achieve this degree of accuracy, careful attention to technique and interpretation is required. Classic CT findings include a distended appendix, periappendiceal inflammation, a caecal bar or arrowhead sign, and an appendicolith.

This pictorial review illustrates many of the pitfalls in the diagnosis of appendicitis, including variant forms, technical pitfalls, mimics of appendicitis and others.

Variants

Atypical locations of the appendix

Variability in the appendiceal location is a well known cause for clinical misdiagnosis, and a false negative CT diagnosis may occur for the same reason (Figure 1).

Tip appendicitis

Obstruction of the appendiceal lumen may occur anywhere along the course of the appendix. Only a small portion of the appendix may be obstructed, resulting in inflammation localized to the appendiceal tip. The inflamed portion of the appendix may be at some distance from the appendiceal origin at the caecal base [2]. Therefore, typical CT signs such as caecal wall thickening and inflammatory changes adjacent to the caecum will be absent (Figure 2).

Close clinical attention to all portions of the appendix is required, including tracing of the appendix from its origin to its most distal portion, in order to avoid missing the diagnosis (Figure 3).

Stump appendicitis

Failure to invaginate the appendiceal stump into the caecum at the time of appendectomy creates the potential for recurrent inflammation of the appendiceal stump [3]. The possibility of such incomplete appendectomies appears to increase with a laparoscopic approach (Figure 4). Most of the recently reported cases involved patients with laparoscopic appendectomies. Furthermore, in patients with right lower quadrant pain but history of prior appendectomy, attention is deflected away from the possibility of appendiceal disease. This fact, coupled with the increasing popularity of the laparoscopic approach, suggests that diagnosis of this unusual complication is likely to increase.

Appendiceal air

Most prior articles have not regarded air in the appendiceal lumen as a useful parameter in diagnosing or excluding appendicitis. Our experience parallels that of Rao [4]. Air filling the appendiceal lumen in a tubular fashion is not seen in patients with obstruction of the appendix (Figure 5a), whereas bubbles of “dirty” air in the appendiceal lumen usually indicate appendicitis (Figure 5b).

Technical pitfalls

CT evaluation in appendicitis may be performed utilizing oral, rectal, and intravenous contrast or none of the above. Usually in patients with sufficient intra-abdominal fat the distended appendix and inflamed perappendiceal fat are easily identifiable. However, in thin patients the diagnosis may be more difficult. In fact, in several series, paucity of intra-abdominal fat represents the most common reason for the false negative diagnosis of appendicitis [5, 6]. The use of enteral contrast appears to be most important in those patients with little body fat.

Received 19 August 2002 and in final form 19 February 2004, accepted 23 April 2004.

Address correspondence to Dr C D Levine, Department of Radiology, Tel Aviv - Sourasky Medical Center, 6 Weizman Street, Tel Aviv, Israel.

Opacification of small bowel with oral contrast allows differentiation of small bowel loops from a distended appendix, particularly when the periappendiceal inflammatory changes are minimal (Figure 6). Additionally, while intravenous contrast is often not critical, abnormal enhancement of the appendiceal mucosa may alert the radiologist to the correct diagnosis (Figure 7).

**Conditions leading to misdiagnosis of appendicitis**

Abscess formation after perforation may occur, often at some distance from the appendix. The abscess may mimic other pathology, often gynaecological (Figure 8).

Appendicitis may result in small bowel ileus with significant dilatation of the small bowel [7]. Oral contrast will progress slowly, leaving the majority of the small bowel unopacified. The non-opacified, dilated small bowel may mask the distended appendix, and lead to an erroneous diagnosis of small bowel obstruction (Figure 9). In those patients with a radiological picture of small bowel obstruction, no history of surgery, and no apparent cause for the obstruction on CT, close attention to the appendix is required to exclude appendicitis.

**Conditions leading to a false positive diagnosis of appendicitis**

A variety of different disease entities may mimic appendicitis. Many of these cause caecal wall thickening which is concentric in nature, such as Crohn’s disease or malignancy, as opposed to the focal caecal thickening typical of appendicitis (Figures 10 and 11).

Crohn’s disease involving the right lower quadrant may also be differentiated from appendiceal disease by the presence of submucosal fat in the thickened bowel wall (Figure 12), or by its multicentric nature.

Caecal diverticulitis may closely simulate appendicitis although the thickening and infiltration of fat is usually centred around the caecum rather than the appendix. The inflamed diverticulum may often be identified to help clinch the diagnosis (Figure 13). Mucocele of the appendix may cause radiological confusion, but its lack of clinical symptoms and absence of surrounding inflammatory changes allow accurate diagnosis (Figure 14).

Gynecological abnormalities such as tubo-ovarian abscess, pyosalpinx, or endometriosis may at times mimic appendicitis (Figure 15).

![Figure 1](image1.png)

**Figure 1.** (a) Normal air-filled appendix located in the inter-aortocaval region (arrow). (b) Normal air-filled appendix in the inguinal canal (arrow). (c) Perforated appendicitis in a patient with an appendix located in the inguinal canal (arrow).
Figure 2. (a) A normal appendix (arrow) extends from the base of the caecum inferiorly. (b) Thickening of the abnormal appendiceal tip (arrow) with marked inflammatory changes in the periappendiceal fat. (c) Coronal reformation showing normal appendix (short arrow) with focal inflammation of appendiceal tip (long arrow).
Figure 3. Perforated tip appendicitis. 70-year-old male with right lower quadrant pain. (a) CT demonstrates a round fluid collection mimicking a distended gallbladder (large arrow) with an apparent gall stone within it (small arrow). (b) At a slightly different level the collapsed gallbladder with mucosal enhancement is identified (small arrow) separate but adjacent to the fluid collection (large arrow). (c) The appendix near its origin is normal without inflammatory changes around it (arrow). (d) At a level between the pericholecystic collection and the normal appendicular origin, inflammatory changes begin to be noted surrounding the appendix (arrow). At surgery the retrocaecal appendix extended cephalad with perforated tip appendicitis and abscess formation adjacent to the gallbladder, mimicking complicated cholecystitis.

Figure 4. Stump appendicitis. A 31-year-old male status post-laparoscopic appendectomy who presented with recurrent right lower quadrant pain. Note infiltration of periappendiceal fat (arrow). Surgery confirmed the diagnosis of stump appendicitis.
Figure 5. (a) 67-year-old male with Crohn’s disease. The appendix is distended and slightly thickened (curved arrow), but predominantly filled with “clean” air. These findings are consistent with a secondary inflammation of the appendix rather than appendicitis due to obstruction. The appendiceal dilatation and thickening resolved with conservative treatment of the patients underlying disease. (b) 40-year-old male with appendicitis. CT demonstrates a distended appendix with enhancement of the periappendiceal wall and multiple small air bubbles within the lumen (arrow).

Figure 6. False positive diagnosis of appendicitis in a 50-year-old male with abdominal pain. Contrast administered only per rectum. Note apparent focal thickening of base of caecum (black arrow), with tubular thickened structure appearing to extend from it (large white arrow), separate from terminal ileum (not shown). Surgery demonstrated no evidence of appendicitis. Use of oral contrast medium may have prevented this false positive diagnosis.

Figure 7. Abnormal enhancement of appendix. 52-year-old male with diffuse abdominal pain. Use of intravenous contrast medium with enhancement of appendiceal mucosa helps differentiate appendix (straight arrow) from loops of small bowel (curved arrow). Appendicitis was confirmed at surgery.
Figure 8. Perforated appendicitis. An 18-year-old female with right lower quadrant pain, fever and leucocytosis. CT demonstrates an enlarged right ovary (large arrow) with small cystic areas in it, adjacent fluid (small arrow) and extrinsic inflammation of the adjacent mesenteric fat (arrowhead). A CT diagnosis of tubo-ovarian abscess or pelvic inflammatory disease was entertained. However, the surgical diagnosis was perforated appendicitis, abscess formation and secondary oedema of the right ovary.

Figure 9. Elderly female with diffuse abdominal pain. CT demonstrates dilated contrast filled small bowel loops (large arrow) with collapse of the right and left colon (small arrows) suggestive of small bowel obstruction. Surgery demonstrated appendicitis. However, an inflamed appendix could not be identified on CT even retrospectively.

Figure 10. (a) 30-year-old male. CT demonstrates typical focal thickening of the caecum (arrow) with an appendicolith noted in its centre. (b) A patient with long history of Crohn’s disease. CT demonstrates a concentric thickening of the caecum (large arrow), atypical for appendicitis.

Figure 11. (a) 83-year-old male with acute onset of right lower quadrant pain. CT demonstrates marked concentric caecal thickening (arrow). (b) CT images slightly caudal demonstrates a dilated fluid filled appendix with an enhancing appendiceal wall consistent with appendicitis. Due to the nature of the caecal thickening, caecal carcinoma with obstruction and secondary appendicitis was diagnosed. Both findings were confirmed at surgery.
Figure 12. Submucosal fat deposition in Crohn’s. A concentrically thickened caecum (arrow) is noted. The wall of the thickened bowel is uniformly low in attenuation due to submucosal fat typical of Crohn’s disease.

Figure 13. Caecal diverticulitis. (a) Inflammatory changes surrounding caecum and appendix (large arrow). Note that although the appendiceal wall is thickened, “clean” air is noted within it (small arrow). (b) CT image slightly superior to (a) demonstrates similar changes adjacent to an inflamed diverticulum (arrow). Note that the diverticulum rather than the appendix is situated at the centre of the changes.
References


Figure 14. (a) Mucocele. Note fluid-filled distended appendix (arrow), typical of a mucocele, in this asymptomatic patient. (b) Appendicitis. A distended fluid-filled appendix is noted (arrow), without inflammatory changes, similar to the appearance of a mucocele. However, this patient had typical symptoms of appendicitis.

Figure 15. Endometriosis involving the appendix. CT demonstrates an enhancing thick-walled appendix (arrow). Surgery demonstrated multiple endometrial deposits, including appendiceal involvement.